Report of the
Bureau of Engineering
1926-1927

Department of Public Works
City and County of
San Francisco
M. M. O'SHAUGHNESSY
City Engineer

SAN FRANCISCO HISTORY ROOM

SAN FRANCISCO
PUBLIC LIBRARY

REFERENCE BOOK

Not to be taken from the Library

N. RANDALL ELLIS.

SAN FRANCISCO PUBLIC LIBRARY
3 1223 03529 8059

MILLS FIELD, SAN FRANCISCO MUNICIPAL AIRPORT

REPORT

OF THE

BUREAU *of* ENGINEERING

OF THE

DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF
SAN FRANCISCO

FISCAL YEAR ENDING JUNE 30, 1927

JAMES ROLPH, Jr. . . . *Mayor*

TIMOTHY A. REARDON
CHARLES E. STANTON
FRED W. MEYER
Board of Public Works

M. M. O'SHAUGHNESSY
City Engineer

*352.5
Sa51c
(1926-27)

Report of the Bureau of Engineering

DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF SAN FRANCISCO
1926-1927

To the Honorable
The Board of Public Works of the
City and County of San Francisco.

Gentlemen:

I herewith transmit the annual report of the Bureau of Engineering for the fiscal year ended June 30, 1927.

One of the notable features of the work of this Department in the latter half of 1926 and the first six months of 1927 was the starting of construction on the Sunset (Duboce) Tunnel. The Duboce Tunnel, as it is generally called, will serve the northern part of the Sunset District and the westerly slope of the Ashbury Heights District—furnishing a low grade transportation route to the upper end of Market Street. Work on the tunnel progressed satisfactorily during the year and at this date, the tunnel is completed and ready for the installation of rails. A contract was awarded and construction started on the laying of tracks through the tunnel and along the proposed route of the railway through the Sunset District to the Great Highway but has been halted by an injunction against the construction, secured by adverse interests in the name of a citizen.

The authorization by the voters of the City of a bond issue for financing the Bernal Cut improvement marks the success of years of effort on this project by this Department. It is also gratifying to note that the people of San Francisco have recently approved our recommendations for construction of boulevards in the City by voting favorably on issuance of bonds amounting to $9,380,000 for this purpose.

Satisfactory progress was made in aqueduct tunnel construction in the Foothill Division of the Hetch Hetchy Project. A new record in excavation of the Hetch Hetchy tunnels—781 feet in one month—established in March, 1927, surpassed the former figure of 776 feet made in August, 1921, and has since been surpassed by a progress of 803 feet, made in September, 1927, which also established a new United States record for such work.

Another source of gratification to us has been the continuous successful operation of the Moccasin Power House for over 22 months with a total net earning in this time of $3,600,000. An additional sum of $329,055 was added to the City's revenue, being derived from payments by the Spring Valley Water Company as rental of the Bay Development aqueduct up to June 30, 1927.

The selection of an airport site and the rapid development of the

field and appurtenances within a year's time was the result of the work of our right of way agent, J. J. Phillips, and my subordinates under W. H. Ohmen, Chief Draftsman of the Design Division of the office.

The record figure of $3,100,000 for street and sewer work completed within a year under the supervision of this department was also established. The award of a contract for grading streets and constructing walls in the Golden Gate Heights District for a sum in excess of $400,000 (a record for street improvements under a single public assessment) marked the culmination of our efforts to make this district suitable for residential purposes.

I must again affirm my obligations to my faithful subordinates, each and every one of whom I have to thank on behalf of the City for their loyal and efficient service. My assistant, Nelson A. Eckart, has been consistently efficient in all that concerns Hetch Hetchy and other public utility activities of the office. Assistant City Engineer, Clyde E. Healy, has been particularly earnest in arranging the streets and sewers program. Paul J. Ost, my Electrical Engineer, for a long number of years, has rendered effective services.

In the death of R. P. McIntosh, whom I brought to the City forces as Hydraulic Engineer upon my advent as City Engineer in 1912, I lost a loyal friend and efficient worker. Mr. McIntosh, who was especially gifted as a mathematician and designer of dams, collaborated with me on the design of the O'Shaughnessy and Lake Eleanor Dams and worked out the details of these and other important structures on the Hetch Hetchy project.

Respectfully,

M. M. O'SHAUGHNESSY,
City Engineer.

CONTENTS

	Page
LETTER OF TRANSMITTAL	i
BOULEVARDS, STREETS AND HIGHWAYS	1
Market Street Extension	3
Grand View Avenue	3
Geneva Avenue	3
Widening Streets	3
Special Treatment Improvements	6
Golden Gate Heights	9
Proposed Highways	9
Bernal Cut	12
SPECIAL PROJECTS AND INVESTIGATIONS	15
Islais Creek Reclamation	15
Bay Bridges	15
STRUCTURES AND MISCELLANEOUS CONSTRUCTION	19
Sunset Tunnel	19
San Francisco Municipal Airport	22
Street Signs	27
Safety Zone and Traffic Lane Appurtenances	27
Sutro Monument and Grounds	27
Douglass & Twenty-Sixth Street Improvements	27
Islais Creek Drainage Culvert	28
Auxiliary Water Supply System Extension	28
Municipal Water Works Extensions	28
Pulgas Preventorium Water Supply System	29
SEWERS	30
Sunset District Sewers	30
Miscellaneous Sewer Extensions	31
Pinelake Park Sewage Pumping Plant	31
Side Sewers	32
STREET WORK PERFORMED UNDER CONTRACTS	33
STREET IMPROVEMENT ASSESSMENTS, ETC.	36
SURVEYS	37
RAILWAYS	39
Market Street Railway	39
California Street Cable Railroad Company	39
Extensions	41
Proposed Bond Issue	42
Sunset Line	44
Embarcadero Bus Line	44
Car Shops and Garage	46
Equipment	46
CURRENT CONTRACT DATA	Insert 47

CONTENTS—(Continued)

	Page
HETCH HETCHY WATER SUPPLY	47
Progress and Development	47
Present Condition of the Project	48
Organization and Headquarters Work	49
Medical Service	53
Watershed Sanitation	54
Mather-Harden Lake-Tioga Road	55
Mather Recreation Camp	55
Automobile Tourist Camp	56
Hetch Hetchy Railroad	57
O'Shaughnessy Dam	58
Lake Eleanor	58
Aqueduct, Mountain Division	58
Moccasin Division	59
Power System	60
Modesto Standby Power Negotiations	60
Power System Operation	62
Newark-San Francisco Transmission Line	63
Aqueduct, Foothill Division	65
Right of Way Acquisitions	65
Roads	66
Red Mountain Bar Cableway	66
Tramway to Brown Adit	67
Power Transmission Line & Telephone Line	68
Rock Crusher at Moccasin Creek	68
Hetch Hetchy Junction Shops	68
Tunnel Construction Contracts Nos. 113C and 113E	69
Moccasin Reregulating Reservoir	73
Tunnel Construction Operations	74
Mechanical Equipment for Tunnel Construction	82
Coast Range Division	84
Study of Alternative Pipe Line Route with Pumping	86
Capacity and General Design of Aqueduct	87
Surveys	87
Right of Way Acquisitions	88
Roads	88
Seco Substation, Transmission Lines and Telephone Lines for Aqueduct Construction	89
Camp Water Supplies	90
Shaft Construction	90
Bay Development	92
Increase of Stored Water in Peninsular Reservoirs	93
Service Connections	94
Pipe Line Protection in Newbridge Park	94
Hetch Hetchy Water Supply Contracts in Force during Fiscal Year 1926-1927	Insert 95
Financial Statement, Hetch Hetchy Project	95

ILLUSTRATIONS AND DIAGRAMS

Page

MILLS FIELD, SAN FRANCISCO MUNICIPAL AIRPORT ....Frontispiece

MARKET STREET EXTENSION 2

GRAND VIEW AVENUE 4

SPECIAL TREATMENT IMPROVEMENTS:—
- Peralta Street easterly from Tomasa Street 5
- Virginia Avenue easterly from Winfield Avenue 7
- Castro Street northerly from 30th Street 7

GOLDEN GATE HEIGHTS:—
- Typical View of Terrain Before Improvement 8
- Walls and Roadway Encircling Knoll 8
- Views of Special Treatment Improvements 10

PROPOSED BOULEVARDS—Map ..... Insert 11

BERNAL CUT—Map 13

ISLAIS CREEK RECLAMATION DISTRICT 16

TRANSBAY BRIDGE—Map of Recommended Locations.....Insert 19

SUNSET TUNNEL (DUBOCE AVENUE ROUTE):—
- East Portal at Duboce Park 20
- Excavating and Timbering 20
- Steel Forms and Concrete Lining 21
- Concrete Gun for Tunnel Lining 21

MILLS FIELD, SAN FRANCISCO MUNICIPAL AIRPORT:—
- General Map ..... Insert 23
- Site Before Starting Improvement 23
- Administration Building 24
- Hangar Building 24
- Airplanes on Field 26

THIRTIETH AVENUE SEWER EXTENSION:—
- Concrete Invert Section 30

MUNICIPAL RAILWAY CAR 40

ILLUSTRATIONS AND DIAGRAMS—(Continued)

Page

MUNICIPAL RAILWAY BUS 45

MATHER RECREATION CAMP SWIMMING POOL 56

HETCH HETCHY AQUEDUCT:—
- Priest Outlet Gate Tower 59
- Moccasin Power Plant 62
- Red Mountain Bar Cableway 67
- Diversion Flume at Moccasin Reregulating Reservoir 74
- Moccasin Portal Tunnel Heading 75
- Hetch Hetchy Junction Shaft 78
- Oakdale Portal 80
- Tunnel Progress—Chart ..... Insert 83
- Shafts on Main Aqueduct Lines—Plan 91

HETCH HETCHY WATER SUPPLY:—
- Annual Expenditures—Chart 104
- Labor and Material Costs, and Number of Employees—Chart.... 104

BOULEVARDS, STREETS AND HIGHWAYS

The rapid development of the unsettled residential areas of the City during the past few years created an unprecedented demand for street improvements. The value of the street improvements handled through this Department under public, private and City-pay contracts completed during the fiscal year 1926-1927 was over $3,100,000, representing an increase of 30 per cent over the preceding year and is almost four times the value of similar work done in 1921-1922.

The above figure does not include the large amount of improvements for which plans and diagrams were prepared during the year, or for which proceedings were started, and which is now under way. In addition, surveys and diagrams were furnished for reconstruction work of the Bureau of Street Repair amounting to over $500,000.

Even more so than in the previous year, the major portion of street improvements was in the southerly and southwesterly sections of the City, viz., the Sunset District, City Land Association Tract, University Mound Tract, Bay View Association Tract, and the new residential districts west of Twin Peaks. Rutland Street, Arleta to Harkness Avenues (6 blocks), Woolsey Street, Colby to Somerset Streets and adjacent streets (12 blocks), Schwerin Street, Visitacion Avenue to the County Line (2 blocks), Munich Street from Excelsior to France Avenues (4 blocks), 14th Avenue, Rivera to Vicente (4 blocks), 34th Avenue, Ulloa to Sloat Boulevard (3 blocks), 45th Avenue, Rivera to Sloat Boulevard (6 blocks), Monticello Street, Holloway to Sargent (3 blocks), Byxbee Street, Holloway to Randolph (4 blocks) and Ralston Street, Garfield to Randolph (3 blocks), were some of the larger local street improvements completed. With the completion of the section of the Westerly Sunset Sewer along Santiago Street, this street, with the exception of three blocks, was paved between 17th and 33rd Avenues and work on many of the adjacent avenues is under way from Rivera to Santiago Streets, this section being dependent for a drainage outlet on the Santiago Street sewer. Similarly, Kirkham, Lawton, and Moraga Streets, from 23rd to 28th Avenues, and 23rd and 28th Avenues inclusive, from Lawton to Noriega Streets, were paved or are under way as the result of the recent construction of a large section of the Central Sunset District Sewer. Following the paving of Judah Street from 31st to 41st Avenues, most of the avenues adjacent to this section of Judah Street southerly to Kirkham Street were improved or put under way.

Fillmore Street from Cervantes Boulevard to Marina Boulevard, 120 feet in width with an 80 foot roadway, was paved. Bluxome Street, a heavy traffic artery, was reconstructed between 4th and 6th Streets. Southern Heights Avenue, the low grade diagonal street recently put through a portion of the Potrero Hills section, between Carolina and Rhode Island Streets, north of Twenty-second Street, was completed with the paving of the roadway and connecting approach streets. Turk Street from Masonic Avenue to Willard Street is being paved. This street was

MARKET STREET EXTENSION

widened to a minimum width of 88 feet, having a roadway of 68 feet between the curbs; the additional land having been given by the Roman Catholic Archbishop of San Francisco and the Presentation Sisters.

Among the residential tracts being improved with streets, sewers, etc., were Mt. Davidson Manor, Westwood Highlands, Balboa Terrace, Miraloma Park, Geneva Terrace, and Pinelake Park.

Market Street Extension:

A contract was awarded and work on the grading and paving of Market Street Extension from Mono to Ord Street was practically completed. The completion of this section marks the finish of the improvement of this extension, commenced shortly after the completion of Twin Peaks Tunnel in 1918. The extension of Market Street over easy grades from its former termination at Castro Street, partly over the right of way purchased for the easterly section of the tunnel, and partly over existing streets by straightening and widening them, to a connection with Portola Drive, provides a direct route via these streets and over Sloat Boulevard from the Ferry Building at the foot of Market Street to the Fleishhacker Playfield at the Ocean Beach in the extreme southwestern section of the City. The present contract, costing $102,500, includes the construction of retaining walls and sewers and the grading and paving of the roadway. The Market Street Railway Company's tracks along a section of this improvement were relocated so as to fit the new line of roadway, the Company doing the work and sharing the cost with the City.

Grand View Avenue:

The grading and macadamizing of the roadway on Grand View Avenue from Stanton Street to a connection with Market Street extension at Elizabeth Street is now under way. This contract also includes the construction of 2,100 feet of sewers and the placing of 1,645 cubic yards of concrete in retaining walls. This improvement will give the Mission district further access to the Market Street Extension, providing a short route between the Mission and the West of Twin Peaks District.

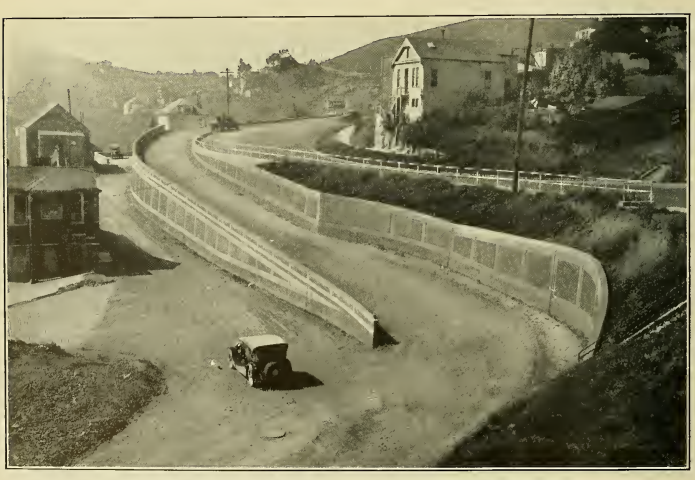
Geneva Avenue:

The completion of the pavement on a 20 foot width of Geneva Avenue from Prague Street to the County Line opened a direct cross-connection to the Bay Shore Highway over Geneva Avenue and Walbridge Street between Mission Street and San Bruno Avenue near and paralleling the County Line, thus eliminating the former circuitous traffic route. Provision was made for a future minimum width of 102 feet for highway purposes along this route.

Widening Streets:

In furtherance of the plan for making San Jose Avenue a part of the proposed crosstown Bernal Cut thoroughfare, embracing also Van Ness Avenue and Capp Street, the section of San Jose Avenue between Gorham and Cotter Streets was widened to a uniform width of 80 feet,

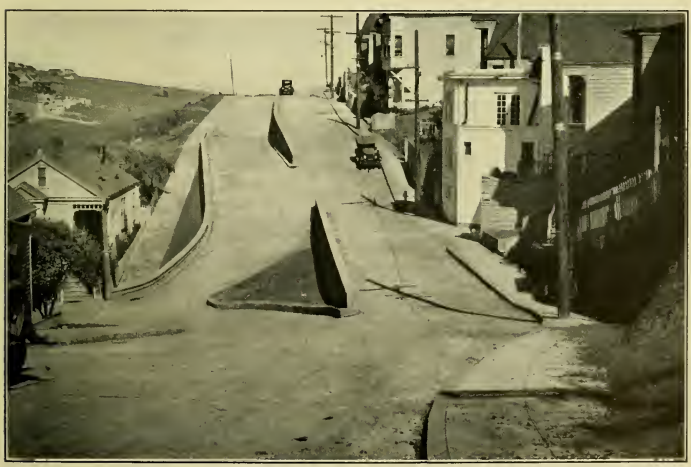
Dividing wall at intersection of street and through roadway



Retaining walls and ramp connecting with Market Street
GRAND VIEW AVENUE

SPECIAL TREATMENT IMPROVEMENT

Peralta Street easterly from Tomasa Street before and after improvement



the City purchasing the necessary property, and the improvement of this section is about completed. Property necessary for the widening of the section between Cotter and Ottawa Streets is now being acquired and a contract for this improvement will soon be let. This will then complete the improvement from Bernal Cut to the County Line.

The widening of the roadway of Kearny Street from Market Street to Columbus Avenue, by cutting down the sidewalk on each side 4 feet, was completed. Similarly, the roadway of Clement Street between Arguello Boulevard and Funston Way was widened four feet and six feet was added to the roadway of Union Street between Franklin and Steiner Streets. These streets all carry double car tracks and, by narowing the walks and setting back curbs, ample width between the cars and parked vehicles has been provided.

Special Treatment Improvements:

Improvements, distinctly local in character but requiring more than the ordinary treatment of local street improvements such as requiring double roadways, retaining walls, stairways, ramps, etc., are known as special treatment improvements.

The following tabulation shows the status at the end of the fiscal year of the several special treatment improvements under consideration by this department.

Location	Length	Approx. Cost	Status
Golden Gate Heights	4½ mi.	$425,000	Under construction
Peralta, Tomasa to Montcalm	1000 ft.	33,000	" "
Montcalm, Tomasa to Peralta	320 "	9,400	Plans completed
Holladay, Peralta to Adams	800 "	45,000	" "
Vermont St., 20th to 22nd Sts	1210 "	35,000	Under construction
Castro St., 29th to 30th Sts	1000 "	20,000	" "
Elizabeth St., Hoffman to Grand View	560 "	14,000	Completed
Laidley St., 30th to Noe Sts	600 "	45,000	Plans completed
Carolina St., 19th to 20th Sts	400 "	9,000	" "
Alpha St., Wilde to Tucker Av	460 "	29,000	" "
Florence St., Vallejo to Broadway	275 "	7,000	" "
Saturn St., Ord to Lower Terrace	650 "	19,500	Completed
Douglass St., 20th to 21st Sts	700 "	35,500	"
Virginia Av., Eugenia to Winfield	370 "	11,000	"
Bosworth and Congo Sts. (Glen Park)	2550 "	30,000	Plans incomplete
Ingerson Av., Hawes to Griffith	1400 "	49.000	" "
Kingston St., Coleridge to Prospect	225 "	9,500	" "
Santiago, 12th to 14th Av.	1000 "	52,000	" "
States St., Castro westerly	500 "	10,000	" "
Wolfe, Peralta and Mullins Intersection		15,000	" "

Virginia Avenue easterly from Winfield Avenue

Castro Street northerly from Thirtieth Street

SPECIAL TREATMENT IMPROVEMENTS

Typical view of terrain before improvement

Walls and roadway encircling knoll.
GOLDEN GATE HEIGHTS

The **Golden Gate Heights** improvement was one of the largest special treatment improvements ever undertaken by this department. This contract was also distinctive in being the largest public contract awarded by the City for street improvements to be assessed upon the property improved under the Street Improvement Ordinance regulating public assessment on street improvements. This improvement was somewhat in the nature of a residential tract development as it included the grading and macadamizing of streets and construction of walls, stairs, etc., of a complete and distinct residential district, (with the construction of sewers and permanent pavement contemplated for the near future), but differs from the usual residential tract development, as generally recognized, in that the property involved was already subdivided and under individual ownership and was not being developed primarily for the purpose of selling lots.

The accomplishment of this contract marks the successful culmination of the efforts of this Department to make an otherwise inaccessible and practically worthless hillside district available and useful for residential purposes. The history of this project—the details of the realignment of streets and re-subdivision of the property—has been described in previous reports. Suffice to mention that through mutual agreement between the City and the property owners, all the property was temporarily deeded to a trust company. Meanwhile this Department planned new easy grade, circuitous streets over the hillsides to replace the steep and impracticable streets of the existing gridiron system and rectangular blocks; and also re-subdivided the property for return to the original owners, who received deeds for the new areas in exchange for their previous holdings. Due credit must here be given to the broad, fine spirit of co-operation shown by the majority of the property owners and especially those conspicuous leaders of the movement in this district, Messrs. Carl G. Larsen and E. D. Lederman.

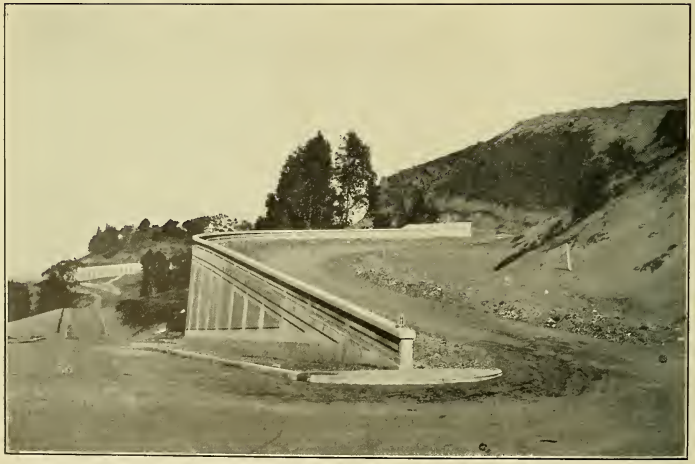
The present contract, approximately estimated as costing $425,000, includes grading of 4½ miles of streets, with 900,000 square feet of macadam surfacing, necessitating over 335,000 cubic yards of excavation and construction of 7,600 cubic yards of reinforced concrete and rubble walls.

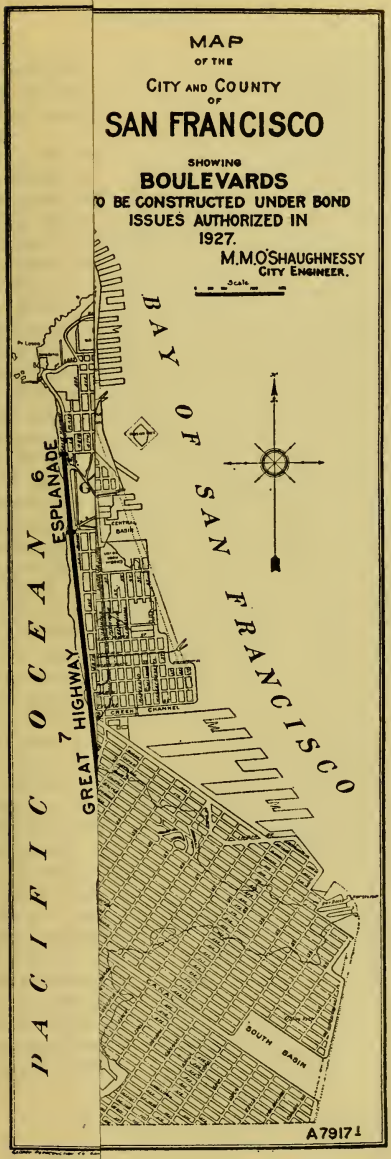
Proposed Highways:

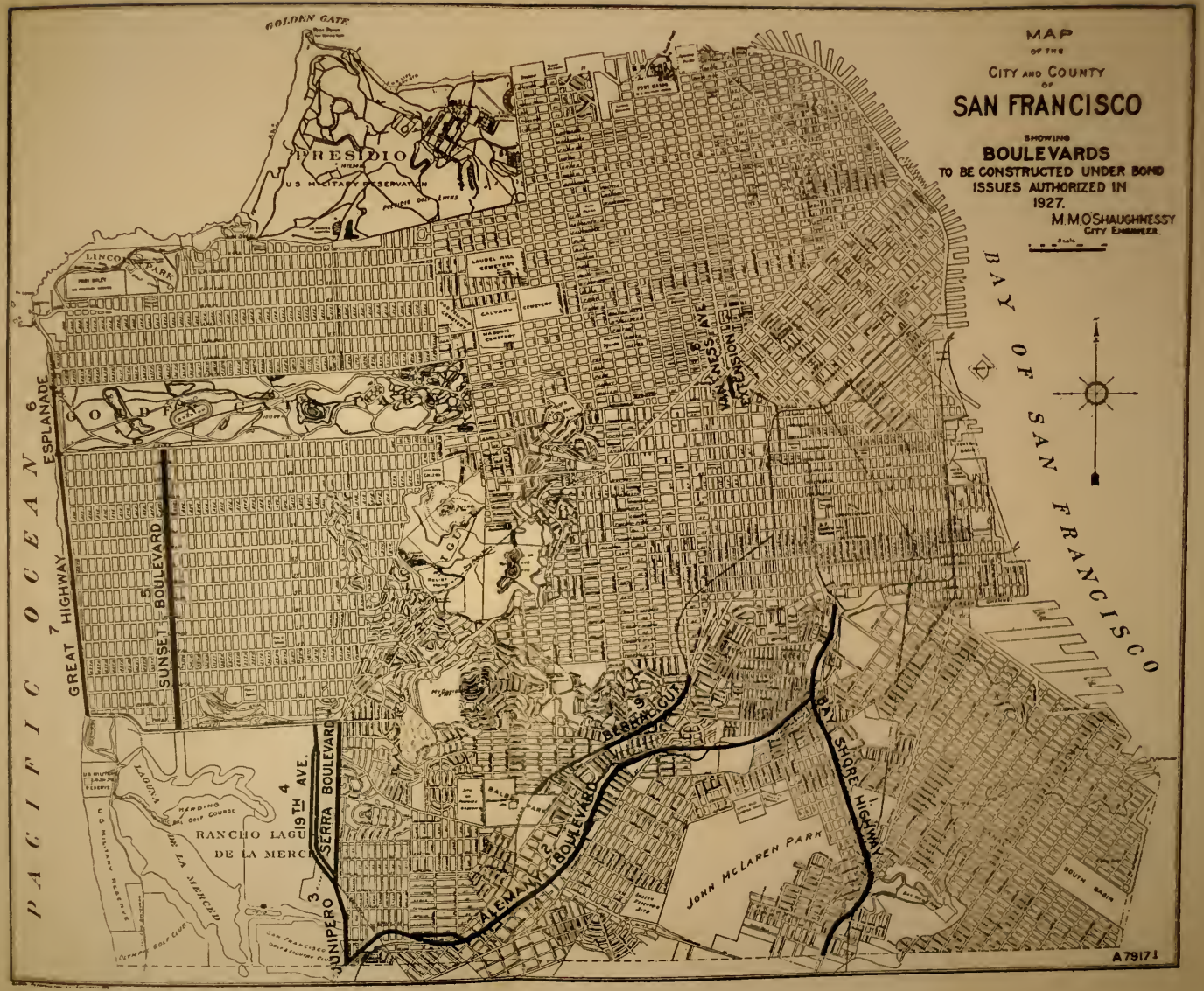
One of the most important problems facing San Francisco today is the development of an adequate highway system. Owing to the City's geographical location on the tip of the peninsula, this problem is not confined to the area within its boundaries but covers the adjacent territory as well, thus requiring for its solution, the development of a regional highway plan for the whole district.

The construction of the Skyline Boulevard by the Joint Highway District, the widening of the bottleneck on the main Peninsula Highway through the cemeteries below Colma by the co-operation of San Francisco and San Mateo Counties, the State of California, and the Market Street

GOLDEN GATE HEIGHTS
Views of special treatment improvements




MAP
OF THE
CITY AND COUNTY
OF
SAN FRANCISCO
SHOWING
BOULEVARDS
TO BE CONSTRUCTED UNDER BOND
ISSUES AUTHORIZED IN
1927.
M.M.O'SHAUGHNESSY
CITY ENGINEER.
Scale
BAY OF SAN FRANCISCO
PACIFIC OCEAN
6
ESPLANADE
7
GREAT HIGHWAY
CENTRAL BASIN
CREEK
CHANNEL
SOUTH BASIN
A7917


MAP
OF THE
CITY AND COUNTY
OF
SAN FRANCISCO
SHOWING
BOULEVARDS
TO BE CONSTRUCTED UNDER BOND
ISSUES AUTHORIZED IN
1927.
M. M. O'SHAUGHNESSY
CITY ENGINEER.
GOLDEN GATE
PRESIDIO
U.S. MILITARY RESERVATION
LINCOLN PARK
LAUREL HILL CEMETERY
CALVARY CEMETERY
GOLDEN GATE PARK
VAN NESS AVE.
EXTENSION
BAY OF SAN FRANCISCO
PACIFIC OCEAN
6 ESPLANADE
7 GREAT HIGHWAY
5 SUNSET BOULEVARD
4 19TH AVE.
3 SERRA BOULEVARD
2 JUNIPERO
1 ALEMANY BOULEVARD
9 BERNAL CUT
BAY SHORE HIGHWAY
JOHN McLAREN PARK
SOUTH BASIN
LAGUNA HONDA
HARDING GOLF COURSE
U.S. MILITARY RESERVE
RANCHO LAGUNA DE LA MERCED
LA MERCED
OLYMPIC GOLF CLUB
SAN FRANCISCO GOLF & COUNTRY CLUB
A79171

Railway Company, and the development of the Bay Shore Highway by the State and the two counties, are all parts of a regional highway plan, without the boundaries of San Francisco, and in which the city is vitally interested.

Within its boundaries, San Francisco must provide a system of traffic arteries and boulevards connecting the different parts of the City with these Peninsula outlets. Such a system has been laid out and preliminary plans and estimates prepared. Portions of the necessary lands in some cases have been procured, in others options have been taken. Funds have been provided in a haphazard manner, heretofore, but in order to carry on the acquisition of rights of way and accomplish the construction in a manner commensurate with the magnitude of the plan, sufficient funds must be provided and a bond issue for $9,380,000 is proposed for this purpose. The following routes for public highway purposes are proposed:

1) A boulevard to be known as the **Bay Shore Highway** from the vicinity of Army Street, Potrero Avenue and San Bruno Avenue, partly along existing San Bruno Avenue and Charter Oak Avenue (both to be straightened and widened) and partly along new rights of way to the vicinity of San Bruno Avenue and Sunnydale Avenue and the County Line, connecting there with the existing Bay Shore Highway to South San Francisco in San Mateo County. The existing section in that County is to be widened and straightened by the State Highway Commission, and extended to the southerly boundary of San Mateo County, a section having already been graded between South San Francisco and Burlingame.

2) A boulevard to be known as the **Alemany Boulevard** from the vicinity of Cortland Avenue and San Bruno Avenue and the proposed Bay Shore Highway, thence in a southerly and westerly direction following the general course of the old Ocean Shore Railway right of way to a connection with the Junipero Serra Boulevard near Palmetto Avenue. The railway right of way from San Bruno Avenue to the County Line has been acquired and additional adjacent property is being procured in order to have a highway 100 feet in width.

3) A boulevard to be known as the **Junipero Serra Boulevard** from the vicinity of Sloat Boulevard and Portola Drive, thence in a general southerly direction, widening and straightening the present Junipero Serra Boulevard to the County Line, connecting there with the existing highway in San Mateo County.

4) A boulevard to be known as **Nineteenth Avenue,** extended southerly from the existing southerly termination of 19th Avenue at Sloat Boulevard, paralleling on each side the Municipal Railway Extension through property known as the Lake Merced lands, and running southerly and southeasterly to Junipero Serra Boulevard.

5) A boulevard and parkway to be known as the **Sunset Boulevard,** 240 feet in width, commencing at Lincoln Way and running in a southerly direction through the central part of the Sunset District to Sloat Boulevard, and passing underneath with an underpass to Lake Merced Boulevard.

6) A beach frontage improvement, being an extension of the present concrete **Esplanade** or seawall, running along and upon the Great Highway west of Golden Gate Park from Fulton Street southerly to Lincoln Way.

7) An improvement of the **Great Highway** from Lincoln Way southerly to Sloat Boulevard.

8) The extension of **Van Ness Avenue** from its present southerly termination at Mission and Twelfth Streets southerly to Howard and 13th Streets.

A summary of the above mentioned projects follows:

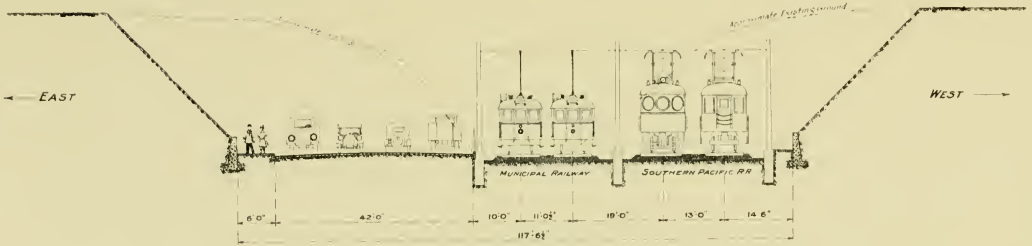
Name	Length Miles	Width Feet	Estimated Cost
1—Bay Shore Highway	3.01	125	$3,365,000
2—Alemany Boulevard	4.80	100	2,365,000
3—Junipero Serra Boulevard	1.80	125	850,000
4—19th Avenue Extension	1.25	128	500,000
5—Sunset Boulevard	2.10	240	*1,900,000
6—Esplanade, Fulton St. to Lincoln Way	.45	188	475,000
7—Great Highway, Lincoln Way to Sloat Boulevard	2.05	120	525,000
8—Van Ness Avenue Extension	.16	125	*500,000
Total	15.62		$9,380,000

*(For acquisition of necessary properties only.)

The proposed **Bernal Cut** improvement is an integral part of the system of highways planned within the City, and will join Dolores Street with the southerly section of San Jose Avenue, near Monterey Boulevard, thus adding another practical through route from Market Street to the County Line. This improvement, planned for years, is now assured of consummation. At a bond election held on June 14, 1927, the voters authorized the incurring of a bonded indebtedness of $1,400,000 for the acquisition, construction and completion of "A cut, or excavation with approach fills, providing an improved route for public highway purposes . . . known as the Bernal Cut . . . including approaches, structures, pavements, curbs, sidewalks, sewers, drainage facilities, the re-adjustment of intersecting and adjacent streets and other improvements, and the purchase of necessary lands." The vote on the bonds was: For 52,623; Against 17,952.

Prior to the bond election, plans for the work had been prepared in considerably greater detail than is customary. On account of the advanced work on the plans, it was possible to purchase property necessary for the work. With $135,000 made available out of the general fund, 33 per cent of the necessary property was acquired, plans were prepared and borings made to determine the character of the ground to be excavated.

LOCATION MAP



BERNAL CUT

TYPICAL SECTION IN CUT
LOOKING SOUTH.

M.M.O'SHAUGHNESSY
CITY ENGINEER.

MARCH 1926

SCALE ¼ IN = 1 FT.

SCALE OF FEET

A7328

Bernal Cut extends from the junction of Dolores Street and San Jose Avenue southerly to the intersection of Diamond Street and San Jose Avenue near Monterey Boulevard. The improvement will be 4,200 feet long, 117 feet 6 inches wide on the bottom, with slopes in the cut proper of 1¼ horizontal to 1 vertical. The bottom width will be apportioned as follows: an 8 ft. sidewalk, a 42 foot vehicular roadway, a right of way for double tracks of the Municipal Railway and a similar right of way on the west side for the Southern Pacific Company, with retaining walls four feet high on either side of the bottom. The railway rights of way will not be paved, but will be fenced off from the vehicular roadway. There will be a sidewalk 6 feet wide constructed on the top of the cut on either side. The present cut of the Southern Pacific Company has a bottom width of 20 feet.

The estimated cost of the project, $1,400,000, is apportioned as follows:

$579,000 for Contract No. 1, $83,400 for Contract No. 2, $18,000 for Contract No. 3, $615,000 to acquire property, $44,600 for engineering, and $60,000 for contingencies.

Contract No. 1 will embrace the following items: 250,000 cubic yards of cut and 50,000 cubic yards of fill; the reconstruction of Randall Street between the Southern Pacific Company's right of way and Chenery Street; the construction of approximately 5,300 lineal feet of masonry retaining wall at the top of slope in the cut; a complete drainage system; a concrete bridge between Richland Avenue and Miguel Street; a concrete bridge extending from the end of Highland Avenue to Arlington Street; the removal of the existing arch bridge, and the construction of a concrete girder bridge at Bosworth Street—estimated cost $250,000. If no delays occur, work will commence on Contract No. 1 by May 16, 1928, and should be completed by September 15, 1929.

Contract No. 2, which will consist of a permanent asphalt pavement in the cut, all curbs in the cut, and a temporary macadam pavement on the fill; walks, coping, and fences; will cost approximately $83,400. Work should commence on this contract about September 30th, 1929, and ought to be completed by the end of January, 1930.

Contract No. 3 will consist of a permanent paving, curbs, walks, coping, and fence, and concrete steps from Bosworth Street to the top of the Bosworth Street Bridge—estimated cost $18,000.

Contract No. 3 should be awarded not sooner than June 30, 1930, so that the fill may have ample time for settlement. If this contract is awarded on June 30, 1930, the entire project should be completed by September 30, 1930.

It will be necessary to remove the existing bridges across the "Cut," i. e., the Charles Street Bridge, and the Richland Avenue-Miguel Street Bridge. The bridges removed will be replaced by reinforced concrete structures, one to be constructed at Highland Avenue and another connecting Richland Avenue and Miguel Street. At Fairmont Street, a small bridge carries the 30-inch riveted wrought iron main leading from San Andres Reservoir to College Hill Reservoir.

SPECIAL PROJECTS AND INVESTIGATIONS

Islais Creek Reclamation:

Work has progressed satisfactorily on plans for the reclamation of the Islais Creek District.

A decision (S. F. case No. 11948) establishing the legality of the District was handed down by the Supreme Court January 21, 1927, in an opinion written by Chief Justice William H. Waste. In accordance with the procedure set forth in the Act of Legislature approved April 6, 1925, the plans were submitted to the Board of State Harbor Commissioners of the State of California and approved by them on May 18, 1927.

The Trustees of the District formally adopted the plans and estimates on May 23, 1927, and filed two copies with the County Clerk on May 26th. On May 27, 1927, they filed plans, certified by the County Clerk, with the Clerk of the Board of Supervisors, with a request that the Board appoint three Assessment Commissioners who shall spread the estimated cost of the work in accordance with the benefits which the individual parcels of land will receive. The appointment of these Commissioners has been referred to the Street and Commercial Development Committee of the Supervisors and is under discussion at this time.

The estimated cost of the project is as follows:

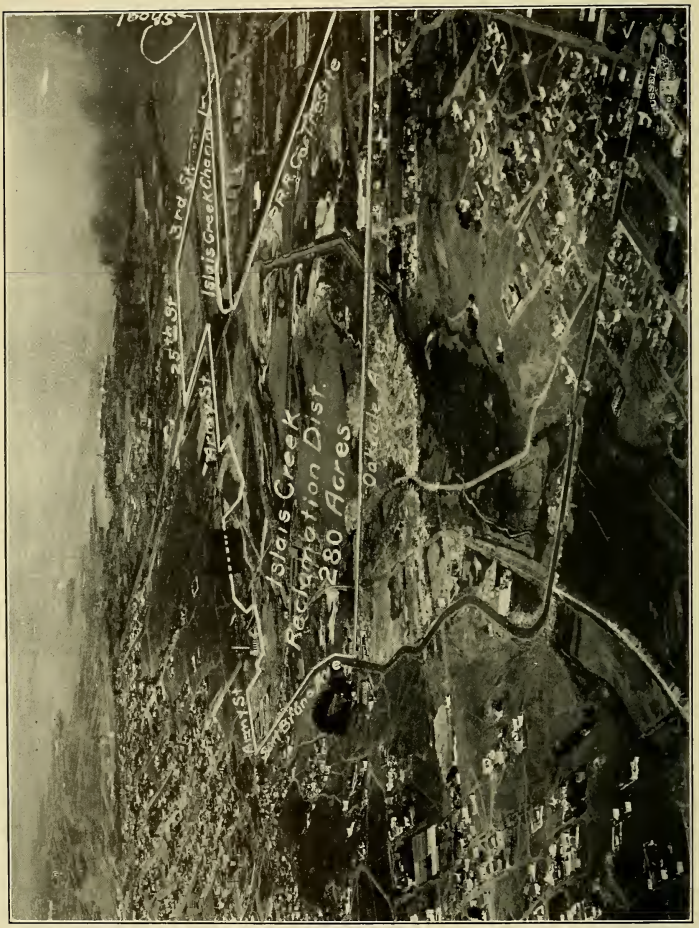
Fill	$ 866,285
Rock bulkhead wall	493,867
Sewer	160.000
Incidentals	50,000
Engineering, Inspection, Collection	50,000
Total	$1,620,152

The 280 acre site was surveyed and a contour map made on a scale of 1 inch equals 40 feet, with 1-foot contour interval. From the contour map, profiles were made so as to obtain the quantities of material for the purpose of estimating costs. Fill was calculated for each lot and each street and crossing.

Bay Bridges:

For many years the subject of a bridge over San Francisco Bay to the east bay cities has been agitated but it is only recently that the necessity for such a bridge has been conceded by practically all interests.

Up to the spring of 1927 eighteen separate applications had been made to the Board of Supervisors for a franchise to construct such a bridge. Right to grant such a franchise is vested in the county on the left bank of the stream descending, but the location is subject to approval by the War Department of the United States at Washington, acting through the military engineers who are in charge of rivers and harbors, and also by the engineer of the State of California.



ISLAIS CREEK RECLAMATION DISTRICT

Hearings about five years ago before the Supervisors led the War Department to announce a policy of no bridge north of Hunter's Point. In December, 1925, a rehearing was had and after several months deliberation the dictum was reannounced.

During the fall of 1926 the Board of Supervisors held public hearings on the applications for bridge franchises but accomplished nothing. On February 15, 1927, the Supervisors authorized the Board of Public Works to employ three expert engineers, selected from a list of ten submitted by the four local universities, to study the bridge problem in collaboration with the City Engineer, and to report their findings to the Supervisors.

The enabling ordinance of the Board of Supervisors outlined their duties substantially as follows: to make a study, investigation and report on the three best locations in the order of their importance, the proper clearance above water, the spaces between piers, the loads, facilities for traffic, and the financial problems involved in construction and completion of a bridge.

On March 24, 1927, the three engineers were appointed: John D. Galloway, Consulting Engineer of San Francisco; Robert Ridgway, Chief Engineer of the Board of Transportation of New York, and Arthur N. Talbot, Professor of Engineering, retired, of University of Illinois, and on April 3rd their studies began. Meetings were held with naval officers, engineer officers, shipping interests, navigators, and others to determine advisable height and width of spans and to settle other physical problems. The facilities of this Department were opened to the Board of Engineers, and plans, maps, photographs, and all available data on soundings, etc., were furnished them. Their report was submitted to the Board of Public Works on May 9, 1927.

The Board of Engineers recommended as the best location that extending from Rincon Hill to Alameda Mole. A loop is provided for interurban trains on Fremont, Tehama, Seventh, and Bryant Streets. Limiting grades on approaches will be 4 per cent for trains and 6 per cent for automobiles. The central section of the bridge over the main part of the bay, 12,000 feet long, will have high level spans with 150 feet clearance above mean high water. There will be two 1250 foot spans next to the San Francisco water front followed by a series of spans of from 750 feet to 500 feet in length. The approach from Alameda Mole will be 4000 to 5000 feet in length. Railway and highway lines will reach Oakland by tubes.

The bridge will be designed to carry on a lower deck three interurban railway tracks, and on an upper deck a highway 42 feet wide, or sufficient for four auto traffic lanes.

Reasons set forth in the report for selection of this route as best are: it is the most available direct route between population centers on both sides of the bay; all existing interurban lines may reach the bridge; the Alameda and Oakland termini reach the principal traffic

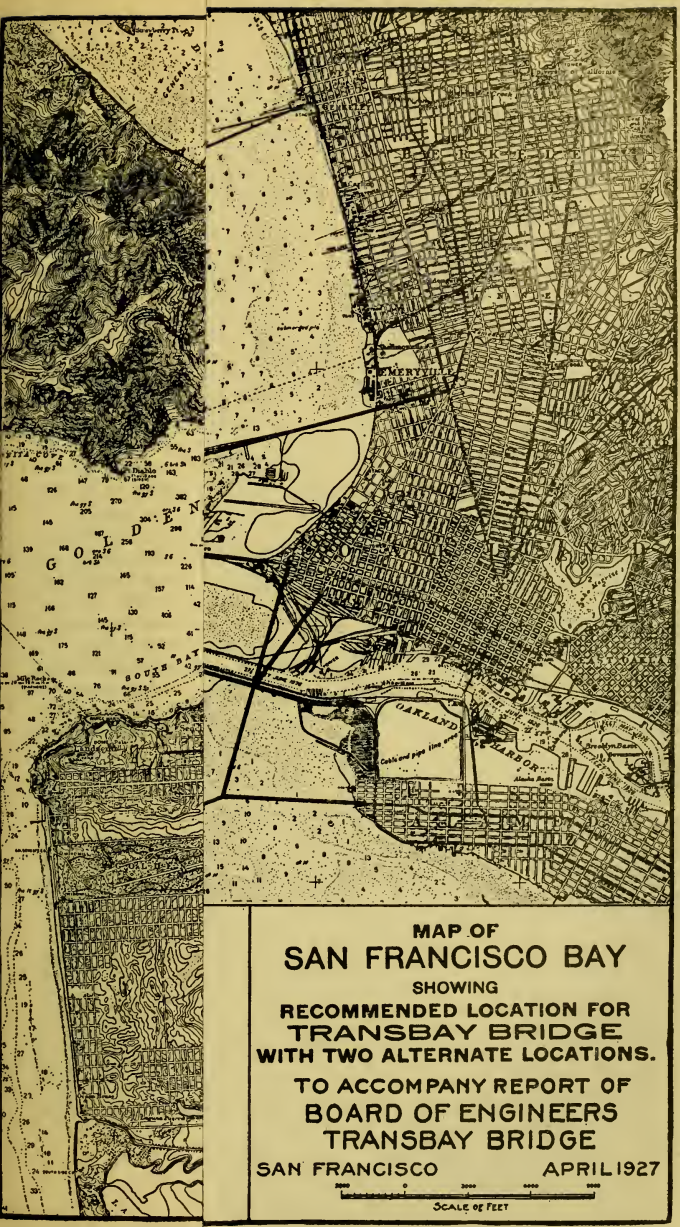
highways; the San Francisco terminus is accessible from the entire street system of the City and is close to the business and shopping districts; interurban and main line passenger stations may be provided; there is storage space for interurban cars; no obstacles to navigation are placed across Oakland harbor; there is no interference with the projected Alameda harbor; the largest existing wharves on the San Francisco water front lie seaward of the bridge; the clearances are all that commercial interests require; there is no interference with the naval anchorage grounds; the existing ferry lanes are left free (though with a bridge in use, ferries may be discontinued); Rincon Hill is an excellent place on which to terminate the bridge; any future rapid transit system may easily be connected to the interurban system and the present street car system can be readily diverted to the terminals.

The report further states: "In the event that Location No. 1 is not available, it is believed that the next best location would lie upon a line extending from Potrero Point at Twenty-second Street to a point south of the inner end of Alameda Mole and west of Pacific Avenue, Alameda. From Potrero Point there will be an elevated railroad extending north on Seventh Street, with a loop on Tehama, Beale, The Embarcadero, and Townsend Streets. On the East Bay side a branch will extend to the foot of Pacific Avenue in Alameda and another to the same points in Oakland as are described under Location No. 1. . . ."

The third best location "would be upon a line from Telegraph Hill to Goat Island and thence by the Key Route Mole to the interurban railroads and to San Pablo Avenue, Oakland." This location would require a bridge 220 feet above high water and spans not less than 1500 feet center to center.

No estimates of cost were submitted, primarily on account of the absolute lack of knowledge of foundation conditions, but it is assumed that difficulties would be very great.

On June 21, 1927, a committee of city officials, comprising Mayor Rolph, City Engineer O'Shaughnessy, City Attorney O'Toole, Supervisors McSheehy, Havenner, and Harrelson, and bridge engineers John D. Galloway and Robert Ridgway, presented the City's arguments for approval of the recommendations of the Board of Engineers for Location No. 1 before the War and Navy Departments in Washington, but failed to get the desired approval. It appears that it will be necessary to get Congressional action to authorize construction of the bridge at the recommended site.



MAP OF

SAN FRANCISCO BAY

SHOWING

RECOMMENDED LOCATION FOR

TRANSBAY BRIDGE

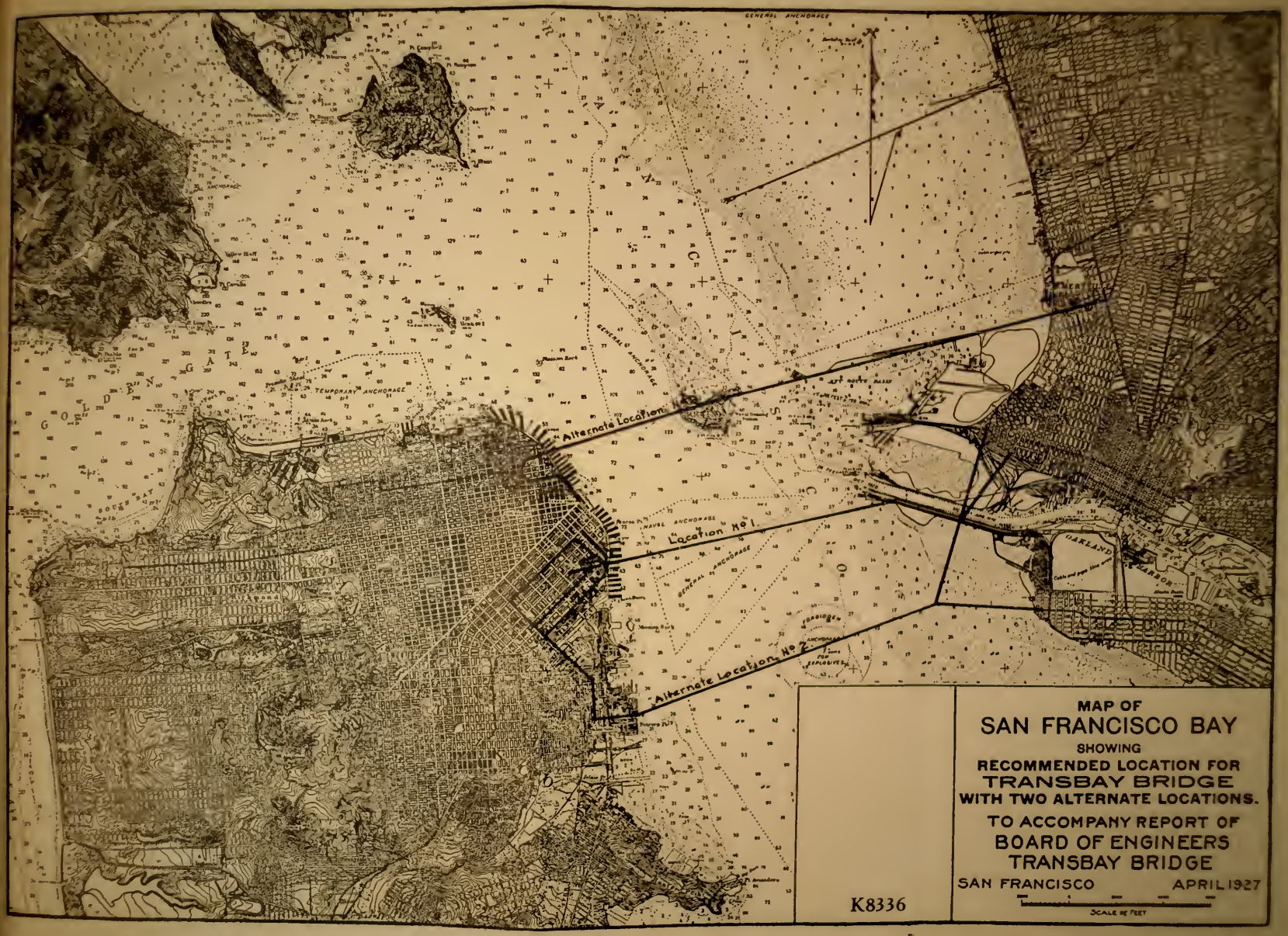
WITH TWO ALTERNATE LOCATIONS.

TO ACCOMPANY REPORT OF

BOARD OF ENGINEERS TRANSBAY BRIDGE

SAN FRANCISCO APRIL 1927

SCALE OF FEET


Alternate Location
Location No 1.
Alternate Location No 2
TEMPORARY ANCHORAGE
GENERAL ANCHORAGE
NAVAL ANCHORAGE
OAKLAND
HARBOR
GOLDEN GATE
SAN FRANCISCO BAY
K8336
MAP OF
SAN FRANCISCO BAY
SHOWING
RECOMMENDED LOCATION FOR
TRANSBAY BRIDGE
WITH TWO ALTERNATE LOCATIONS.
TO ACCOMPANY REPORT OF
BOARD OF ENGINEERS
TRANSBAY BRIDGE
SAN FRANCISCO APRIL 1927
SCALE OF FEET

STRUCTURES AND MISCELLANEOUS CONSTRUCTION

Sunset Tunnel:

As noted in the Annual Report for 1925-26, ground breaking ceremonies were held June 10, 1926. Since then work has progressed in a markedly satisfactory manner and it is expected that the tunnel will be completed by the end of the calendar year.

The tunnel is 4,232 feet long from the east portal at Duboce Avenue and Noe Street to the west portal in the block bounded by Clayton, Carl, Cole, and Frederick Streets. There are two curves to the south, one extending for 86 feet at the east portal, and one in the open cut at the west portal. East portal is at elevation 155 feet. The grade rate, ascending westerly, is .030 to west portal. The tunnel, as designed for double track standard gage electric railway, is 25 feet in width and has 18 feet 9 inches clearance above rail grade. It is to be lined throughout with concrete, the section varying with the class of earth encountered. In soft earth the arch thickness is 22 inches and the walls at spring are 33 inches. In rock the arch thickness is uniformly 18 inches. Invert is 12 inches thick.

Funds are provided by an assessment district of 1,129 acres westerly from the tunnel. The assessment varies from 5 cents to 1½ cents per square foot, according to the benefits to be derived from the operation of the tunnel. Two methods of payment were open to the property owners, either a cash payment of the entire sum at one time, or ten annual installments with interest at 7 per cent on the deferred payments.

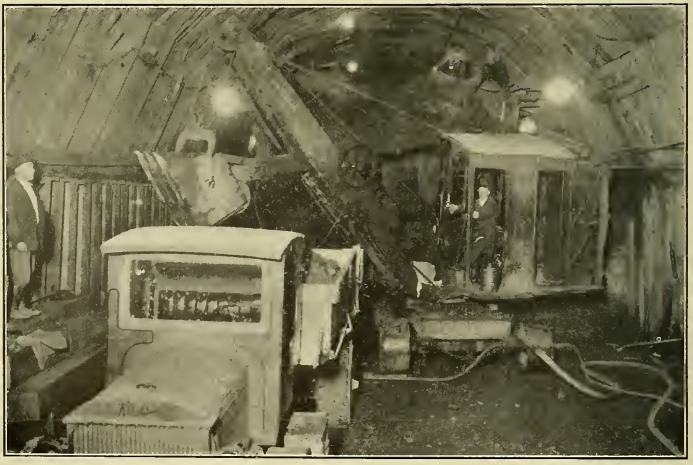
Before the tunnel contract was let, suit was brought by some property owners opposed to the assessment in an attempt to prevent the work by attacking the validity of the Tunnel Procedure Ordinance. The case is now in the Supreme Court, but it is expected, as was the case in the Twin Peaks Tunnel, that the tunnel will have been completed and the cars running before a decision is handed down by that tribunal.

The tunnel is being excavated by driving a pilot drift in the crown and two wall plate drifts and removing the core by air-operated "steam" shovel. Contrary to the usual practice the driving of the pilot drift has been shoved well ahead of the wall plate drifts, for two main purposes: first, to provide efficient and economical ventilation, and second, to explore the geological formations to be encountered. The pilot drift was holed through on March 11, 1927.

Timbering consists of 10x12 arch timbers on 12x14 wall plates supported by 10x12 vertical posts, generally at 5 foot centers but set closer as the weight of ground requires.

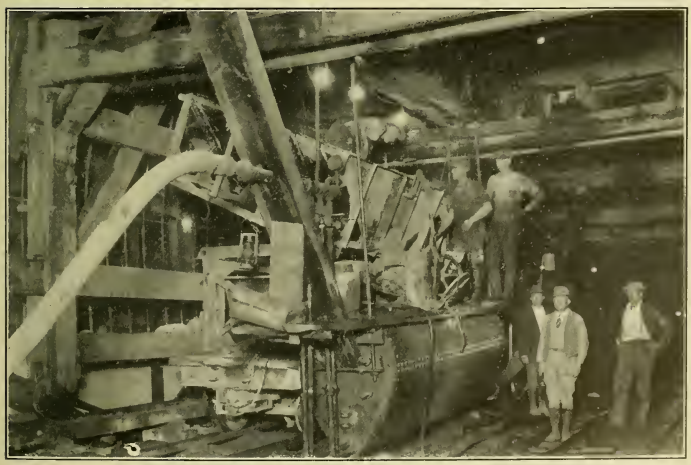
Placing of concrete lining has followed as closely as possible after the excavation. Very careful proportions in mixing of the concrete ingredients, especially of the sand, cement, and water, have resulted in high grade concrete ranging from 2700 to 3000 pounds on a 28-day test. Concrete mixing was under the direction of C. L. Cook, chemist of this Department.

East Portal at Duboce Park



Excavating and timbering
SUNSET TUNNEL (DUBOCE AVENUE ROUTE)

Steel forms and concrete lining of sides and arch



Concrete gun receiving concrete for tunnel lining
SUNSET TUNNEL (DUBOCE AVENUE ROUTE)

Reinforcement of the concrete in the walls for the earth section consists of two curtains of steel spaced 12 feet vertically and 24 inches horizontally. For the rock section one curtain of steel is used, spaced as above to the spring line and 24 inches both vertically and horizontally above the spring line.

Excavation near the portals, where the covering overhead was rather thin, was somewhat slow, owing to the difficulty of holding up the badly weathered surface layer of serpentine. The caving of small quantities of this material resulted in slight settlement of some houses, but these were quickly repaired by the contractor under the provisions of the specifications.

At present the two approaches are about 90 per cent complete, the excavation 75 per cent, and the concrete lining 45 per cent, the total value of the work done being about $930,000. M. J. Bartell and E. F. Muheim are resident engineers on construction.

San Francisco Municipal Airport:

During the fiscal year, the City has acquired a site for and put in service an airport equal to any in the United States. This is one of the first airports in the country to be established entirely by a municipality.

The budget for 1926-27 carried an item of $100,000 for airport development. In the fall of 1926, this office investigated all possible airport sites in the Bay district and on November 1st, 1926, rendered a report covering the extent, possibilities and estimated cost of six sites which were thought worthy of consideration. These were located at South San Francisco, San Bruno, Millbrae, San Mateo and Beresford. This report estimated a cost of $350,000 for essential equipment and facilities for a typical airport for any location, exclusive of cost of the land and its development by necessary drainage, filling, levee construction, etc.

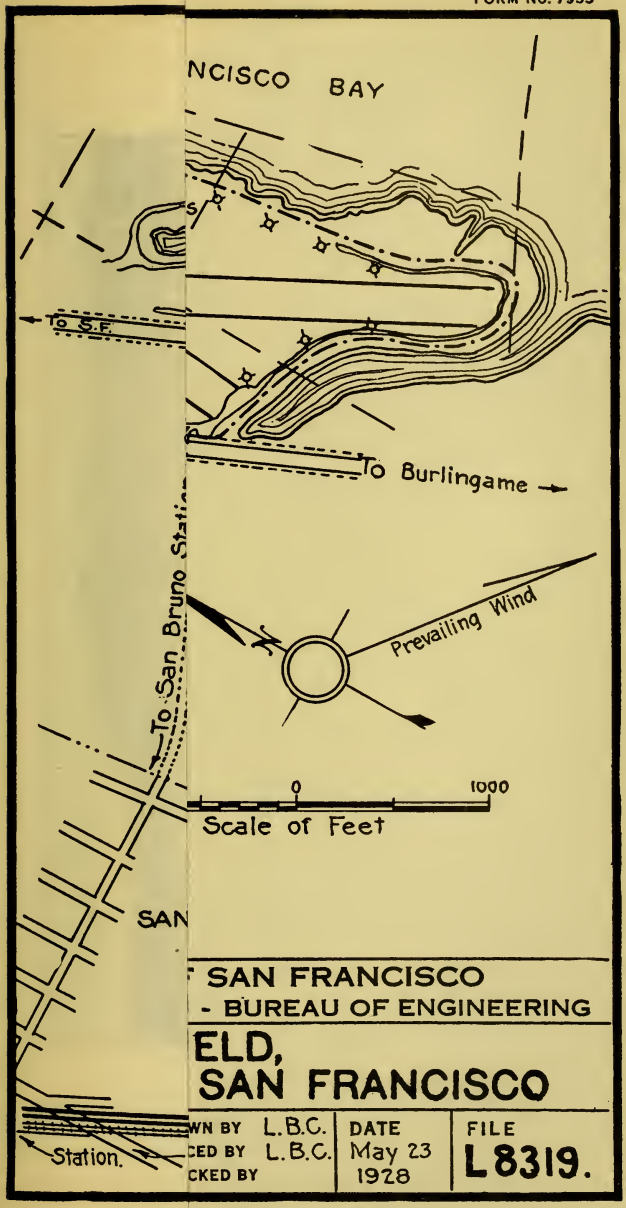
Essential equipment includes:

9000 feet of sodded earth runway,
2 hangars, each housing 12 planes,
Night lighting equipment,
Radio equipment,
Wind cones, markers, etc.,
Meteorological station,
Machine shop,
Gas and oil service equipment,
Fire fighting equipment,
First-aid equipment,
Rest stations, etc.,
1 mile of concrete road on field.

Other facilities, the cost of which would vary greatly with the several sites, are:

Landing ramp for hydroplanes,
Creosoted timber wharf,
Water service to field,
Railroad spur track.

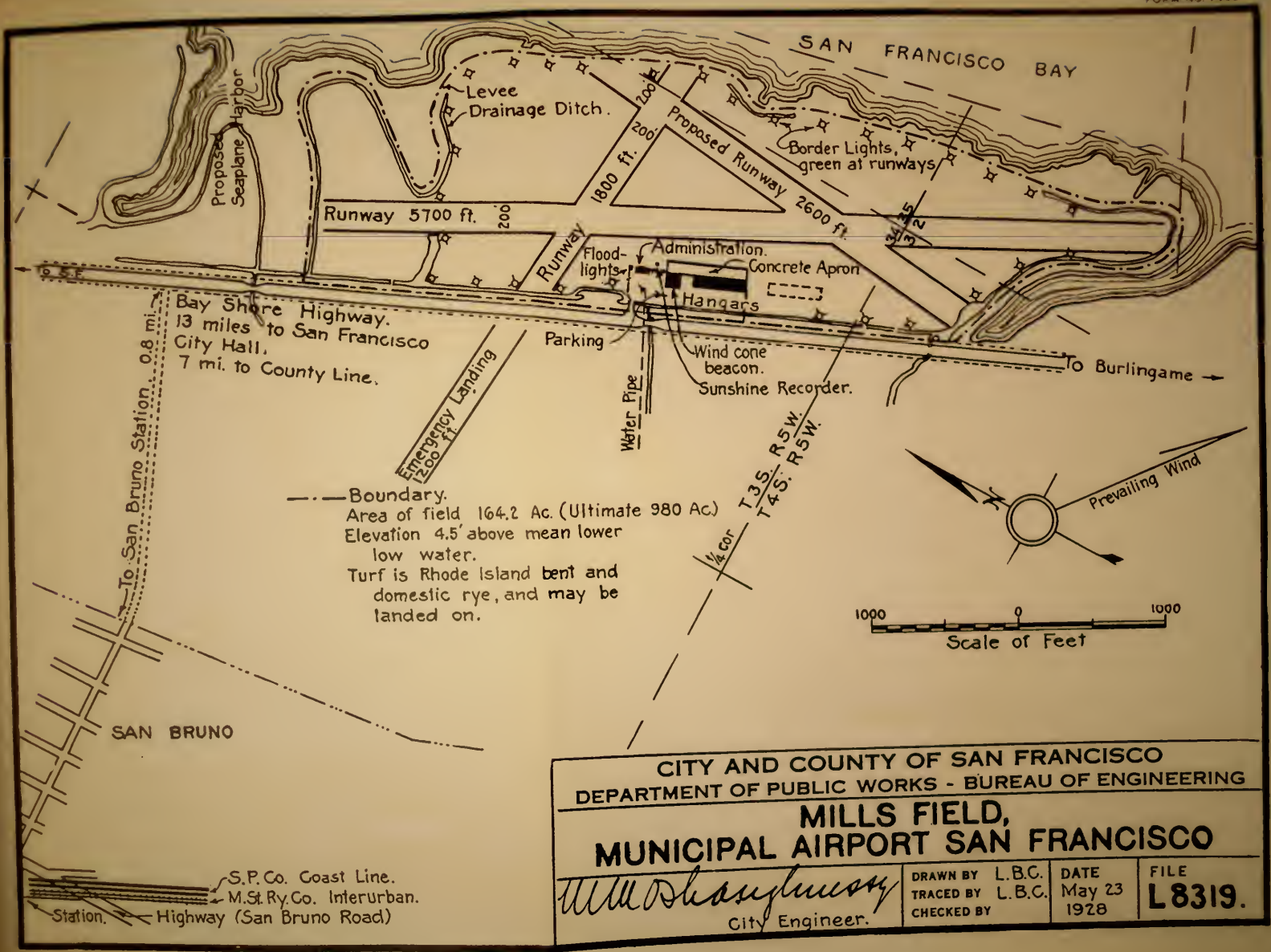
FORM No. 7935



SAN FRANCISCO
- BUREAU OF ENGINEERING

ELD,
SAN FRANCISCO

WN BY L.B.C.	DATE	FILE
CED BY L.B.C.	May 23	L8319.
CKED BY	1928	

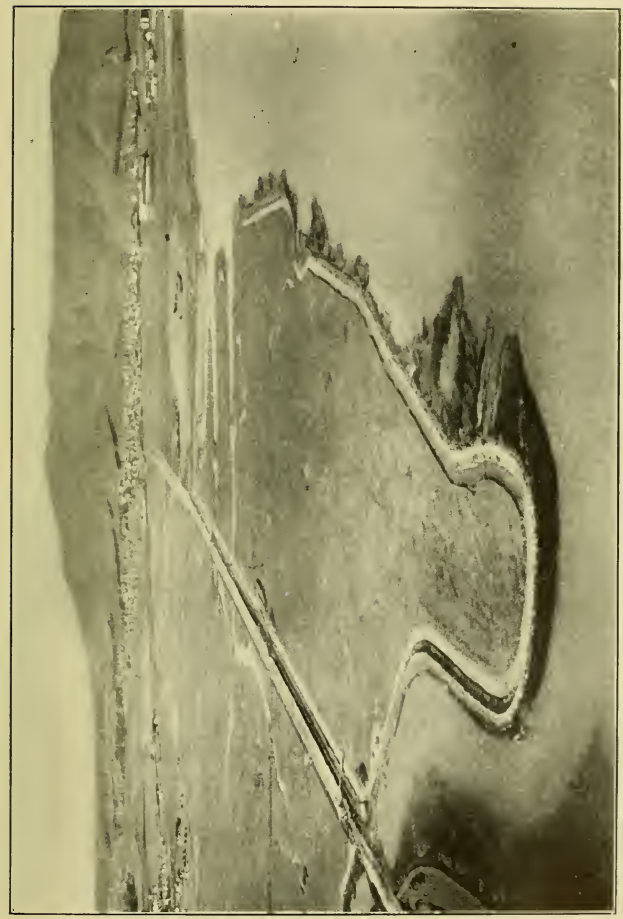


CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS - BUREAU OF ENGINEERING

MILLS FIELD, MUNICIPAL AIRPORT SAN FRANCISCO

City Engineer.

DRAWN BY	L.B.C.	DATE	FILE
TRACED BY	L.B.C.	May 23 1928	L8319.
CHECKED BY			



MILLS FIELD, SAN FRANCISCO MUNICIPAL AIRPORT
Site before starting improvement

Administration Building

Hangar Building No. 1
MILLS FIELD, SAN FRANCISCO MUNICIPAL AIRPORT

An estimate of cost of completely developing each site was made. For ultimate size of 3000 feet by 5000 feet, the estimated costs ranged up to $1,500,000. Time of construction of such permanent fields would be about two years.

The report was discussed on February 14th, 1927, by the Board of Supervisors. It developed that the full size permanent field would not be necessary for perhaps five years and that the selection of such a field should be made only after meteorological observations extending over a year. Most favorable conditions for speedy completion as a temporary field were shown for Mills Field at San Bruno.

Mills Field is on the Bay Shore Highway, fourteen miles southerly from San Francisco. This site has a present land area of about 160 acres with possibility of increase by land reclamation up to 1000 acres and is closer to San Francisco than most of the other sites submitted.

After thorough discussion, the Board of Supervisors on March 17th, 1927, unanimously passed Ordinance No. 7428 authorizing the lease of this site for a three year period with privilege of extension to five years, at an annual rental of $1,500. A Charter amendment had been passed by the electorate on November 2nd, 1926, by a vote of seven to one authorizing purchase of lands outside of the City and County for use as an airport.

It is the intention to use this field for the term of the lease and to carry on meteorological investigations at this and other suggested sites. As a result of these observations, the City will be in a position better to select a permanent airport.

The field as at present in use, includes three runways 200 feet wide laid out as the sides of a right triangle and extended. These runways are respectively 5,770 feet, 2,750 feet and 1,850 feet in length. They are heavily macadamized, well crowned for drainage, are in excellent condition in any weather and are capable of carrying a 20,000 pound plane at 80 miles per hour. Water supply is from connection to San Bruno pipe line through 4,200 feet of 3 inch pipe. Static head is 115 pounds per square inch.

Administration Building is located on the westerly edge of the field close to the entrance from the Bay Shore Highway. This temporary building, 33 feet by 87 feet, of frame construction, provides office room, hospital and meteorological department, all thoroughly equipped. Meteorological studies and reports are handled by the United States Weather Bureau. Space set aside in the building for a lunch room is not yet occupied.

Northerly from the administration building is the motor generator house, 12 feet by 12 feet, with two 18-inch high intensity arc floodlights mounted on a platform 10 feet by 12 feet and operated by a 14 K. W. generator. Each floodlight spreads the light to a fan of 80° with 1,000,000 cp. on the field and covers approximately 50 acres. The lights may be trained along the runways if desired. Thirty-two border lights at 300 feet intervals surround the field. Globes are of clear glass ex-

cept at approaches to runways, where they are green. Telephone poles on the line to the field are surmounted by red obstruction lights.

Southerly from the administration building and separated from it by clear space of 150 feet is Hangar No. 1, a fireproof building of 10,000 square feet area. The building is of galvanized, corrugated steel, with galvanized steel trusses and columns, with concrete floor resting on 28 piles 60 feet long. The building is portable as it is considered as only temporary.

A beacon tower on this hangar, 40 feet above the ground, carries a 24 inch revolving beacon with automatic lamp changer. An illuminated wind cone 15 feet long is also located on this building. Buildings and roofs are painted white, excepting that on the roof of Hangar No. 1 are the words "Mills Field, San Francisco Airport" in white on a black background.

A tentative general plan for the ultimate improvement of the airport has been completed. This plan contemplates the construction of eleven hangars, each of about 30,000 square feet area. Detail plans are now under preparation for temporary Hangar No. 2, to be situated about 50 feet southerly from Hangar No. 1. This hangar is now taxed to capacity to house the rapidly increasing fleet of ships.

An enviable record of speed in construction was set up on this work.

MILLS FIELD, SAN FRANCISCO MUNICIPAL AIRPORT
Airplanes lined up on field during second State Aeronautical Conference

On February 18th, 1927, the California Development Association requested the use of the airport for the second State Aeronautical Conference on May 5th, 6th and 7th. Through strenuous effort on the part of the City Engineer's staff, the field was ready for the conference.

Street Signs:

The marking of the streets with a standard type of sign has been systematically carried out for several years in accordance with a plan prepared in this office, and now the main business district, several local business and residential sections, and many of the leading highways are marked. To date 2895 type "A" signs, consisting of 4 porcelain name plates in frames on pipe standards, have been erected at main intersections; and 578 type "B" signs—single name plates on redwood backing—have been placed on buildings or improvements on the smaller streets and alleys.

During the past year, 541 type "A" signs were erected, replacing the gas lamp signs in Hayes Valley and the greater portion of the Western Addition, and in parts of the Mission District, and also for marking sections of Judah Street, Ulloa Street, and Twentieth Avenue in Sunset District, and streets in the Crocker-Amazon Tract. In addition thereto, 167 type "B" signs were placed, mainly in the Western Addition.

Safety Zone and Traffic Lane Appurtenances:

Over 54,000 markers, defining pedestrian traffic lanes at street crossings, were installed under Contract No. 2 for such installation, continuing the work started in the previous year under the first contract. Further progress on this work has been temporarily held up over the question of the right of local manufacturers to supply the marker called for.

The first unit of 2500 safety zone buttons included under the contract for installation of the same has been installed and, taking advantage of the favorable price bid, the contract has been extended to include another unit of approximately the same number of buttons.

Sutro Monument and Grounds:

Improvements were made to Sutro Monument and surrounding grounds on the summit of the rock knoll known as Mt. Olympus. Concrete walls were constructed, concrete stairways built from Upper Terrace and Seventeenth Street, stone sidewalks and asphaltic pavement laid, and loam placed on the terraced ground to provide for planting grass and shrubs, so that this memorial of one of our City's former executives would be more accessible to the public and be of more pleasing appearance.

Douglass and Twenty-sixth Streets (City Lands) Improvements:

The former quarry site at Twenty-sixth and Douglass Streets, purchased by the City, was improved by leveling the quarry floor, constructing drainage gutters and enclosing the playground with a galvanized iron

wire fence over the high bluffs surrounding the quarry. The property thus improved has been turned over to the Playground Commission who will equip and maintain it as a playground, which is greatly needed in this neighborhood.

Islais Creek Drainage Culvert:

The filling in of the Alemany Boulevard along the route of the old Ocean Shore Railway west of San Bruno Avenue, and of the adjacent property by the owners, blocked off the drainage of Islais Creek through the old railroad culvert just west of San Bruno Avenue, and it was thought best to divert the flow back into the old original Islais Creek Channel further west. This necessitated replacing an old box culvert with a larger culvert. A timber structure, 62 feet in length with a width of 12 feet and clear height of 7 feet 2 inches, was completed under contract during the year.

Auxiliary Water Supply (High Pressure) System Extension:

The placing of high pressure mains in the Butchertown District of the City, as part of the auxiliary water supply system for fire protection, has relieved the packing and slaughter house district from the risk of devastating fire. Approximately 10,000 feet of pipe, consisting of 9650 feet of 12-inch, 600 feet of 8-inch, and 260 feet of 16-inch, was laid and 28 hydrants were installed. Three fire boat manifold connections were placed on the lines at selected points along Islais Creek Channel. Connection was made with the Spring Valley Water Company's pipe on Third Street. Pending the construction of the connecting line from the mains of the City's high pressure system to the new lines, the Spring Valley connection and the fire boats, acting through the manifolds, will serve as source of supply for the system.

Plans are being prepared for this connecting line, which will start at Harrison and Twenty-fifth Streets, thence over Twenty-fifth Street, Potrero Avenue, San Bruno Avenue, Napoleon Street and Evans Avenue to the new line at Evans Avenue and Rankin Street, and, with the by-pass line along Army Street will require laying of 2 miles of 12-inch pipe.

With provision for this work in the budget for the next year, a contract will soon be let and this line completed. This connecting line will then afford protection to the industrial plants rapidly being built throughout the district adjacent to this route as well as insuring a high pressure supply to the Butchertown system.

Municipal Water Works Extensions:

The Municipal Water Works is a municipally owned water supply system serving a district in the southeasterly section of the City which cannot be reached by the privately owned company's present pipe system, the supply being pumped mainly from wells. The system has approximately 950 services and 58 fire hydrants on its 16 miles of pipe. The pipe ranges from 2-inch to 8-inch in size with exception of 1100 feet of 12-

inch main. There are two storage reservoirs on the system, one with a capacity of 500,000 gallons and the other with 30,000 gallons.

The water is pumped from wells into the storage reservoirs. At the present time one well is in use and supplies approximately 135,000 gallons per day. The average daily consumption throughout the system for the past year was 147,000 gallons, the additional supply being taken from the Spring Valley Water Company's system and pumped into the storage reservoirs.

Two main extensions were made during the year, one of 2500 feet along Brussels Street from Harkness to Olmstead, thence to Goettingen and Mansell Streets—the other of 1870 feet on Rutland Street from Leland Avenue to Wilde Avenue.

Extensions made for the benefit of any particular properties are paid for by the owners of the property. For major reconstruction work it is generally necessary to appropriate City funds; otherwise the system is practically self-sustaining, even though the fire hydrants are maintained without charge to the Fire Department (the City pays the privately owned Company $3.00 per year for each hydrant service throughout the City).

Pulgas Preventorium Water Supply System:

A water supply system for fire protection and domestic supply for the City's Tubercular Preventorium was designed and installed at Pulgas, San Mateo County, under supervision of this Department.

Water is taken from the 5 foot diameter Hetch Hetchy Aqueduct line leading into Crystal Springs Reservoir, through a six inch connection at elevation 281 feet, and is pumped through a 4-inch pipe line to an 80,000 gallon redwood storage tank at elevation 670 feet. A 4-inch discharge line distributes the water to three fire hydrants and to the Preventorium domestic supply lines. The maximum pressure at the fire hydrants is 56 pounds per square inch. The two pumping units consist each of two 22-inch multi-stage centrifugal pumps direct connected to a 40-horsepower motor. Each pumping unit has a capacity of 157 gallons per minute against a total head of 456 feet. Pressure controlled electric switches regulate the automatic operation of the pumps. A chlorimeter on the pump discharge line chlorinates the water before entering the storage tank. The cost of the complete installation was $15,000.

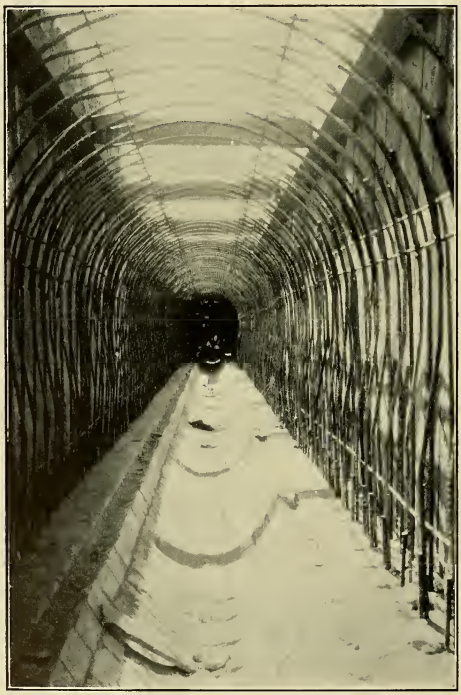
SEWERS

Sunset District Sewers:

Work on the two lateral sewers draining the central area of the Sunset District, construction on which was started during the previous year as described in the last annual report, is progressing rapidly. Completion of this work will clear the way for the improvement of a large district as the drainage area of these sewers comprises over 815 acres.

The two end sections of the Westerly Sunset (Forty-third Avenue) District Main which were started during the previous year, were completed this year and construction on the intervening section is well under way.

A section of the Sunset Central District Main was constructed on Noriega Street from Twenty-forth Avenue to Twenty-ninth Avenue. Plans



THIRTIETH AVENUE SEWER EXTENSION
Concrete invert section and side and top reinforcement

are prepared so that the construction will soon be started on the section along Twenty-ninth Avenue and Thirtieth Avenue connecting with the recently completed Thirtieth Avenue outlet section at Kirkham Street. The Noriega Street section was constructed previous to this connecting section, in order to hasten the paving of Noriega Street, as sufficient money was not available at that time for both sections.

Miscellaneous Sewer Extensions:

A 12-inch pipe sewer was constructed in Sunnydale Avenue from Schwerin Street to Hahn Street to serve as a temporary connection from the Sunnydale District to Visitacion Valley to the main outlet sewer—1186 lineal feet of 15-inch and 286 lineal feet of 12-inch sewer being laid. Eventually as this district becomes fully developed, it will be necessary to replace this temporary sewer with a 3 foot by 4 foot 6 inch concrete sewer—meanwhile a saving of $9,000 was made by building the pipe sewer.

Contracts have been awarded and work started on extensions to the Canal Street Sewer and the Stanley Street Sewer, and on construction of a sanitary sewer for Fleishhacker Playfield.

The Stanley Street Sewer is being extended to allow filling in of a deep ravine adjoining the present storm outfall, and involves the construction of approximately 500 feet of 3 foot by 4 foot 6 inch concrete sewer partially on piers.

The Canal Street sanitary sewer will be extended by the construction of 1060 lineal feet of 18-inch pipe sewer, thus placing the outfall of this sewer below the residential tracts developed adjacent thereto. This sewer is serving as a temporary outlet of the sanitary system draining over 5 square miles of the Upper Islais Creek district west of Mission Street Viaduct.

The sanitary sewage flow of this district, which now empties into Islais Creek, is intended to be diverted into North Point Main. To accomplish this requires the construction of 6160 feet of 4 foot by 6 foot sewer, of which 4200 feet would be in tunnel, along Mission Street and under St. Mary's Hill, at an estimated cost of $300,000. Until this amount of money is available this concentrated sewage is being discharged temporarily into Islais Creek through the Canal Street Sewer.

To provide a sanitary sewer connection for Fleishhacker Playfield it will be necessary to construct approximately 700 feet of 8-inch sewer, and in order to safeguard the swimming pool from contamination, cast iron soil pipe with leaded joints is specified.

Pinelake Park Sewage Pumping Plant:

A sewage pumping plant is being designed for Pinelake Park District, a residential tract now being laid out and improved in the southerly part of the Sunset District. An area of 56 acres from Nineteenth Avenue to Thirty-fourth Avenue between Sloat Boulevard on the south and Vicente Street on the north drains into Laguna Puerca, a small lake

in the center of the district at the westerly end of Trocadero Gulch. The elevation of the water level of the lake is +30, from which elevation the surrounding area rises to an elevation of over +90. Under the proposed sewerage plan, the sanitary flow of the area will be carried to a sump at about elevation +25 and pumped into the Sunset District main at Thirty-fourth Avenue and Wawona Street at elevation +85. The storm flow of the district will empty into the lake, the waters of which percolate through the sands westerly toward the ocean. This lake, which is approximately 300 by 1450 feet in size and 22 feet in depth, maintains a constant water level varying very slightly between dry weather period and rainy season.

Side Sewers:

During the past year, 2013 applications for side sewers were received (many applications being for 2 or more sewers) and $146,610.45 was collected for installing the sewers. This represents a decrease of 759 in number of applications and of $30,502 in collections over corresponding figures for the previous year. This was due to the inauguration of a system under which all contracts for construction of main sewers must provide for the construction of all side sewers connecting with the sections of main sewer. Under this system the cost to property owners is less and the life of the pavement laid later will not be shortened by being cut into for side sewer trenches.

Side Sewer Installations

Date	Number of Applications	Amount Collected
1926		
July	154	$ 10,672.25
August	153	10,496.50
September	145	11,067.00
October	196	15,384.05
November	196	13,765.70
December	164	11,574.75
1927		
January	184	13,070.30
February	139	10,846.10
March	202	15,213.50
April	168	11,513.25
May	150	10,818.00
June	162	12,189.05
	2013	$146,610.45

STREET WORK PERFORMED UNDER CONTRACTS

JULY 1, 1926 to JUNE 30, 1927

	Quantity	Cost
Asphaltic Concrete Pavement, 6″ concrete base; wearing surface 1½″, paint coat	508,007 sq. yds.	$1,393,995
Asphaltic Concrete Pavement, 6″ concrete base; wearing surface 1″, binder 1½″	8,656 sq. yds.	18,796
Asphaltic Concrete Pavement, 3½″ black base; 1½″ wearing surface	9,874 sq. yds.	17,289
Asphaltic Concrete Pavement, with concrete strip: wearing surface 1½″, paint coat, 6″ concrete base	17,513 sq. yds.	48,745
Concrete pavement 6″	7,675 sq. yds.	21,432
Asphaltic Surface—conform	4,248 sq. yds.	3,452
Asphaltic Binder—conform	18 tons	144
Concrete pavement, 6″	91,432 sq. yds.	252,138
Concrete Pavement with brick strip,		
Concrete pavement 6″	2,331 sq. yds.	6,292
Vertical fibre brick	2,226 sq. yds.	10,016
Vitrified Brick Pavement,		
Vertical fibre brick	86 sq. yds.	346
Basalt Block Pavement, 6″ concrete base	64 sq. yds.	172
Basalt Block Pavement—reset	80 sq. yds.	90
Gutters, concrete	2,648 sq. yds.	9,344
Curb:		
Granite (new)	112 lin. ft.	269
Granite (reset)	165 lin. ft.	50
Granite (redressed and reset)	12,330 lin. ft.	7,371
Concrete (armored)	264,580 lin. ft.	272,723
Wheelguards, concrete	1,874 lin. ft.	1,735
Coping, concrete	242 lin. ft.	382
Headers, redwood	7,907 lin. ft.	498
Sidewalks, artificial stone	40,073 sq. yds.	60,008
Grading:		
Cut	191,244 cu. yds.	199,978
Fill	117,047 cu. yds.	73,685
Areas	550,309 sq. ft.	310,467

Street Work Performed Under Contracts—(Continued)

	Quantity	Cost
Retaining Walls, Stairs, etc:		
Concrete		20,031
Reinforcing steel	9 tons	1,304
Pipe Railings	722 lin. ft.	2,528
Fence, pipe rail and concrete posts	60 lin. ft.	180
Sewers (reinforced concrete):		
5′6″ circular	2,997 lin. ft.	59,303
3′x4′6″ egg-shaped	1,244 lin. ft.	19,089
2′6″x3′9″ egg-shaped	3,410 lin. ft.	44,810
2′x3′ flat top	2,260 lin. ft.	15,978
Taper, Junction and Outlet Structures	4 only	1,075
Sewers, ironstone pipe		
6″ (side sewers)	21,296 lin ft.	25,253
8″	60,314 lin. ft.	151,645
10″	125 lin. ft.	625
12″	14,580 lin. ft.	45,267
15″	6,535 lin. ft.	24,021
18″	2,505 lin. ft.	8,761
21″	925 lin. ft.	3,773
Y-branches:		
On 8″ sewer	3,377 only	5,066
“ 10″ sewer	27 only	54
“ 12″ sewer	616 only	940
“ 15″ sewer	257 only	723
“ 18″ sewer	108 only	143
“ 21″ sewer	62 only	195
Manholes:		
On concrete sewer	35 only	3,150
On ironstone pipe sewer, new	375 only	44,271
On ironstone pipe sewer, rebuilt	1 only	68
Drop, on ironstone pipe sewer	1 only	150
Lampholes	1 only	125
Catchbasins:		
New	458 only	53,577
Reset	74 only	4,880
Stormwater Inlets:		
New	5 only	500
Rebuilt	9 only	780

Street Work Performed Under Contracts—(Continued)

	Quantity	Cost
Culverts:		
6″ ironstone pipe	150 lin. ft.	150
8″ ironstone pipe	16 lin. ft.	16
10″ ironstone pipe	13,175 lin. ft.	30,288
Septic Tank	1 only	245
Miscellaneous:		
Conforms, drainage, etc.		3,399
TOTAL COSTS		$3,281,779

Summary—Cost of Street Work:

Work under public contracts	$ 489,805
Work under private contracts	2,452,465
Work under City pay	339,509
TOTAL	$3,281,779

STREET IMPROVEMENT ASSESSMENTS, ETC.

Assessments and Bonds for Street Work

Assesments issued for cost of street work performed	88
Cost of street improvements covered by assessments	$577,464.14
Bonds prepared (in triplicate)	290
Amount of assessments guaranteed by bonds	$135,435.04
Average amount guaranteed by each bond	$ 487.02

Street Work Proceedings

Resolutions of Intention passed	69
Street improvements recommended under Resolution of Intention	163
Notices of street improvement posted	2,184
Notices of Resolution of Intention mailed	5,612
Ordinances ordering performance of street improvements passed	120
Proposals of street improvements published	149
Public contracts for street improvements awarded	108
Private contracts filed	521

Notices, Permits and Investigations

Notice to construct and repair sidewalks	3,063
Notice to construct bulkheads	552
Notice to remove obstructions	609
Notice to construct guard rails	18
Notice to reconstruct side sewers	372
Street space permits reported on	4,201
House moving permits reported on	146
Miscellaneous calls and investigations	3,209

Permits and Fees for Corporation Trenches and Main Line Extensions

	Service Connections	Mains Lineal Ft.	Fees
Pacific Gas and Electric Co.	5,585	39,429	$8,694.00
Spring Valley Water Co.	4,038	24,598	6,257.25
Pacific Telephone & Telegraph Co.	452	16,948	835.50
Great Western Power Co.	57	13,195	187.50
Western Union Telegraph Co.	7	535	16.50
Postal Telegraph Cable Co.	—	4,335	33.00
*Miscellaneous under Special Deposits	—	—	6,093.50
Total	10,139	99,040	$22,117.25

*Permits granted for which special deposits were made to move steam shovels and tractors, to repair or install oil tanks, service pipes, fire alarm wires, cables and conduits, to lower curbs, etc.

SURVEYS

Surveys performed

For public contracts	98	
For private contracts	692	
Resurveys for contracts	232	
For Municipal Departments	399	
Total for Public Improvements, etc.		1,421
Lot Surveys:		
For private owners	41	
For Municipal Departments	7	
Total Lot Surveys		48
Total Surveys		1,469

Surveys include approximately 2,673 blocks and crossings, a total of 910,000 feet or 172 miles, in addition to 30 miles of monument line and highway work and the replacing of 83 monuments. In addition to this there was the laying out of the Airport, Bernal Cut, Golden Gate Heights, Grand View Avenue, Bernal Heights Boulevard, and Lake Merced Panhandle Extension.

Precise Levels and Bench Marks

District	Number of Bench Marks	Precise Levels
50 Vara	92	1.90 miles
100 Vara	536	14.20 "
Sunnyside	82	3.20 "
Fairmount	215	6.00 "
Railroad-Homestead	47	1.80 "
Market Street Extension	169	6.40 "
Bernal Heights	50	2.00 "
Sunset	544	14.40 "
Lake View and City Land Tract	125	4.70 "
Other Districts	1128	30.20 "
Total	2988	84.80 miles

Maps Approved and Recorded

S.W. corner California Street and Presidio Avenue.
Utah Street (south of Twenty-fifth Street), closing.
Grafton Avenue Extension.
Oloran Alley—Colonial Way and Nantucket Avenue Opening.
Ellington Avenue Closing.
San Bruno Avenue Widening at Flower Street.
Monterey Heights—Blocks 3044-5; 3039; 3042; 3047.
Pinelake Park (parcels deeded to City).
Miraloma Park Subdivision No. 2.

Maps Approved and Recorded—(Continued)

Alemany Tract.
Pinelake Park.
Russian Hill Place Opening.
Miguel Street Widening.
Twenty-sixth Street Extension.
Lundy's Lane.
Bauer Street and San Juan Avenue—Realignment at Cayuga.
Park Street Extension.
Public Alley—Sunset Block 962.
Southard Place Widening 50 V. 265.
Noriega Street Widening 21-31.
Turk Street Widening.
Miraloma Park Subdivision No. 3.
Homestead Manor.
Noriega Street Widening 31-48.
Addition to Assessor's Block No. 6905.
Southern Hillside Unit No. 2.
Vista Del Mar.
Pinelake Park Subdivision No. 1
Robson Tract
Blaine, Deering and Samuels Tract.
Stanyan Street Extension.
Balboa Terrace Addition.

Fees Received for Surveys and Inspection

Month	Surveys	Inspection
1926:		
July	$2,172.00	$2,147.85
August	1,730.00	1,716.75
September	1,380.50	2,768.45
October	1,532.50	6,493.85
November	713.50	2,298.10
December	1,707.40	3,389 50
1927:		
January	1,350.87	1,990.10
February	3,655.85	7,466.95
March	4,528.90	7,938.90
April	9,842.28	5,410.30
May	2,241.60	2,006.10
June	7,973.20	6,646.35
Total	$38,828.60	$50,273.20

RAILWAYS

Market Street Railway:

Except that we are one year nearer the expiration of the franchises of the Market Street Railway, there is no change in the situation as outlined in the last annual report of this Department. Neither has there appeared, as preparation for attacking the problems that will be forced upon the City when these franchises expire, any better procedure than the following, quoting from this same report:

"The problem of working out a satisfactory plan of operation which would give the ultimate in service to the public is not one of tremendous difficulty from a physical point of view. It will, however, be difficult to reach a solution which will be satisfactory to the Municipal authorities, the Market Street Railway Company, the general public and the self-constituted critics and amateur experts. However, if the problem is approached with open minds and with an honest desire to solve it in the best interests of the public, there is no doubt that a satisfactory solution can be worked out. This, however, must be done within the next two years in advance of the franchise expirations; and as an initial step, I would recommend that a sufficient appropriation be made so that this office may make a proper study of the situation and prepare a report covering the several possible solutions of the problem in order that the Board of Supervisors and the public may have all of the necessary information before them to reach a sound decision in the matter. It is estimated that the sum of $50,000 should be made available for this purpose which would provide for the employment of any necessary experts in the matter.

"Such a report would designate the line of the company which will not be used or useful, what additional track should be constructed to make the most efficient system and the routing of the cars to give the best and most economical service on the unified lines. The report would indicate what results may be expected financially from the combined systems under Municipal control. The effect on traffic congestion would also be included as well as other matters necessary for consideration as a part of the problem as a whole. With such a report at hand the Board of Supervisors and the general public would be in position to intelligently determine a policy to be followed in all street railway matters."

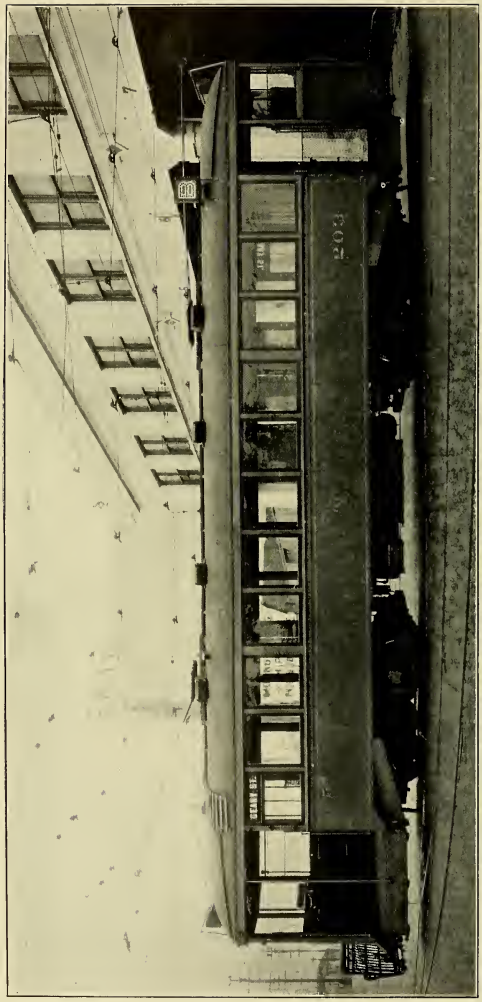
A complete report based on a comprehensive study and analysis of the street railway situation is essential as a first step toward a solution of the problem, and no plan of action can be formulated intelligently without such analysis.

Such a report cannot be hastily made and at least six months or more should be allowed after money is appropriated. After submission of the report it must also be realized that there should necessarily be allowed time for its study and discussion and no doubt some time for negotiations with the existing companies in connection with price, operating conditions, etc.

I cannot too strongly emphasize the fact that the necessary authorization and appropriation should be made by the Supervisors for this work.

California Street Cable Railroad Company:

The Board of Supervisors, by Resolution No. 24451, adopted August 31, 1925, declared for the policy of acquiring the California Street sys-



MUNICIPAL RAILWAY CAR

Type of car designed by Department of Engineering for use on Municipal Railway lines

tem, and directed the Public Utilities Committee to negotiate with the Company and report to the Board. Nothing further, however, has been done at this writing. The California Street railways franchises expire February, 1929.

Extensions:

No additions to the street railway mileage were made during the past year, by either of the private corporations or the Municipal Railway. The unsettled situation has long since prevented any extensions by the private companies, and no funds are available for construction by the Municipal System, except the Sunset Line for which $500,000 was appropriated in September, 1921. To date additions and betterments amounting to approximately three million dollars, more than one-third of the Railway's entire investment in road and equipment, have been made from surplus funds derived from the operation of the Municipal Railway. These surplus funds are practically depleted and as pointed out in previous reports, it is not probable, with the increased operating expenses due to the higher wages and material costs, that further extensions can be made from earnings.

The following table shows the Municipal Railway's operating ratio for each year since its establishment. The comparison is made between the revenue derived from fares, and the actual expenditures necessary to keep the cars and buses moving, not including interest or reserves:

Year ending	Pas. Rev.	Oper. Ex.	Ratio
Dec. 31, 1913	$ 444,748	$ 206,789	.465
Dec. 31, 1914	1,150,236	613,939	.534
June 30, 1915	1,630,778	923,388	.566
June 30, 1916	1,970,478	1,164,617	.591
June 30, 1917	1,470,193	966,138	.657
June 30, 1918	2,363,366	1,402,438	.593
June 30, 1919	2,391,176	1,661,044	.695
June 30, 1920	2,702,289	2,025,867	.750
June 30, 1921	2,868,616	2,116,976	.738
June 30, 1922	2,884,815	2,154,566	.747
June 30, 1923	2,993,829	2,302,055	.769
June 30, 1924	3,173,181	2,460,283	.775
June 30, 1925	3,268,383	2,544,516	.779
June 30, 1926	3,395,950	2,705,146	.797
June 30, 1927	3,398,187	2,879,906	.847

In this tabulation can be seen the steady upward climb of operating costs. In other words, in the first few years of Municipal operation, in order to produce one dollar of passenger revenue, an expenditure of little more than one-half of that amount was required. Today the railway must spend nearly eighty-five cents to earn a dollar, leaving the scant margin of approximately fifteen cents to cover interest charges, depreciation and other items.

Nevertheless, a comparison of the operating costs of the Municipal Railway with those of several of its neighbors under private management shows that in almost every item except "Conducting Transportation," which reflects the higher wages paid by the City, the Municipal costs are lower.

Proposed Bond Issue:

Obviously the only practicable method of financing extensions to the Municipal System is through the issuance of bonds, and in a report to the Board of Supervisors, on November 6, 1926, I recommended as the basis of a $3,500,000 bond issue, the following additions to the Municipal Railway System:

1. Car repair shop at 17th and Hampshire Streets.
2. Garage.
3. Extension into the Marina District.
4. Additional facilities for the Sunset Line.
5. Extension through the Bernal Cut into the Excelsior District.
6. Extension through the Richmond District via Balboa Street.
7. Extension from the Taraval Street Line to the Municipal Swimming Pool at Sloat Boulevard and the Great Highway.
8. Additional automobile buses.

This recommendation was submitted after careful consideration, and no extension was proposed which was not justified economically, and which would not fit in with a single citywide street railway system. In the report it was pointed out that consideration of many other suggested extensions, some of them meritorious, might well be deferred until they could be studied in connection with the acquisition of the private companies.

By direction of the Supervisors the so-called Eureka Valley Line was added, and on March 31, 1927, the following revised estimate was transmitted to the Board of Public Works:

March 31, 1927.

The Honorable
The Board of Public Works of the
City and County of San Francisco:
Gentlemen:

Pursuant to the provisions of Ordinance No. 7447 (New Series), finally passed by the Board of Supervisors March 14, 1927, and approved by the Mayor on March 25, 1927, and in accordance with instructions from your Board as per Resolution No. 96648, I transmit herewith plans and estimates of cost of original construction and completion of certain extensions of the existing Municipal Street Railway, including the extensions and additions to the trackage and facilities of said Municipal Railway System, together with the necessary equipment and appurtenances thereto, and the purchase of necessary lands, all as set forth in Ordinance No. 7447 (New Series).

The total route of the track construction involved in the extensions covered by the ordinance is 14.45 miles, and the bus route mileage is 1.1 miles. The mileages involved in the several extensions along the routes which I have tentatively chosen for estimating purposes are as follows.

1.	From the existing Municipal Railway track at Scott and Chestnut Streets into the Marina Tract west of Scott Street and north of Chestnut Street	0.86 miles
2.	From the Municipal Railway track at Masonic Avenue and Turk Street into the Richmond District, connecting with the Municipal Railway tracks running to the Ocean Beach via Balboa Street	2.54 miles
3.	From the Municipal Railway tracks on Market Street at Duboce Ave., through the Sunset-Duboce Tunnel into the Sunset District and through the Sunset District to a terminal near the Ocean Beach	4.74 miles
4.	A connecting crosstown service west of Twentieth Avenue between the above described Sunset District extension and the existing Municipal Railway tracks on Taraval Street	1.30 miles
5.	From the Municipal Railway tracks at Forty-sixth Avenue and Taraval Street, southerly to a terminal near Wawona Street and Forty-seventh Avenue	.63 miles
6.	From the Municipal Railway tracks at Thirtieth and Church Sts., southwesterly through the Bernal Cut, into the Excelsior District, at or near Excelsior Street; thence southerly through the Excelsior District to a terminal at Geneva Avenue	2.78 miles
7.	From Seventeenth Street and Market Street in a southwesterly direction to, at or near Eureka Street and Market Street; thence in a southerly direction on and over Eureka Street or other most feasible route to Twenty-third Street at or near Eureka Street; thence in an easterly direction on and over Twenty-third Street or other most feasible route to Diamond Street; thence in a southerly direction on or over Diamond Street or other feasible route to Twenty-ninth Street	1.60 miles
	Total length, route miles	14.45 miles
8.	An automobile bus service from the vicinity of Seventeenth Street and Potrero Avenue by the most feasible route to the vicinity of Twenty-third Street and Wisconsin Street	1.10 miles
	Estimated cost of real estate and rights of way	$ 575,000
	Estimated cost of track construction, including electric work incidental thereto	2,335,000
	Estimated cost of car barns, shops, garages, and appurtenances	535,000
	Estimated cost of cars and automobile buses	1,400,000
	Total	$4,845,000
	Less appropriations already made for Sunset District extension, Resolution No. 19262 (N. S.) of the Board of Supervisors	500,000
		$4,345,000
	Engineering, extras, and incidentals	355,000
	Total	$4,700,000

The plans of the extensions are shown on a map attached hereto, which indicates the routes tentatively chosen to carry out the provisions of the ordinance. This ordinance gives some latitude as to the exact streets on which the extensions are to be constructed to serve the several

districts, and it is understood that the locations shown on the plan may be modified within the limits of the ordinance where necessary on account of difficulties arising, either physical or legal.

The exact site has not been chosen for the Sunset carbarn, as this would not be done until we are in a position and had the funds available to purchase the property.

It is recommended that your Board approve these plans and estimate of cost, and transmit the same to the Board of Supervisors.

Respectfully,
M. M. O'SHAUGHNESSY,
City Engineer.

The proposition of incurring a bonded indebtedness of $4,700,000 to cover the project as outlined above, was submitted to the voters at a special election on June 14, 1927. The final vote was "Yes," 44412; "No," 25791. Failing to secure the necessary two-thirds vote, the proposition was defeated.

Sunset Line:

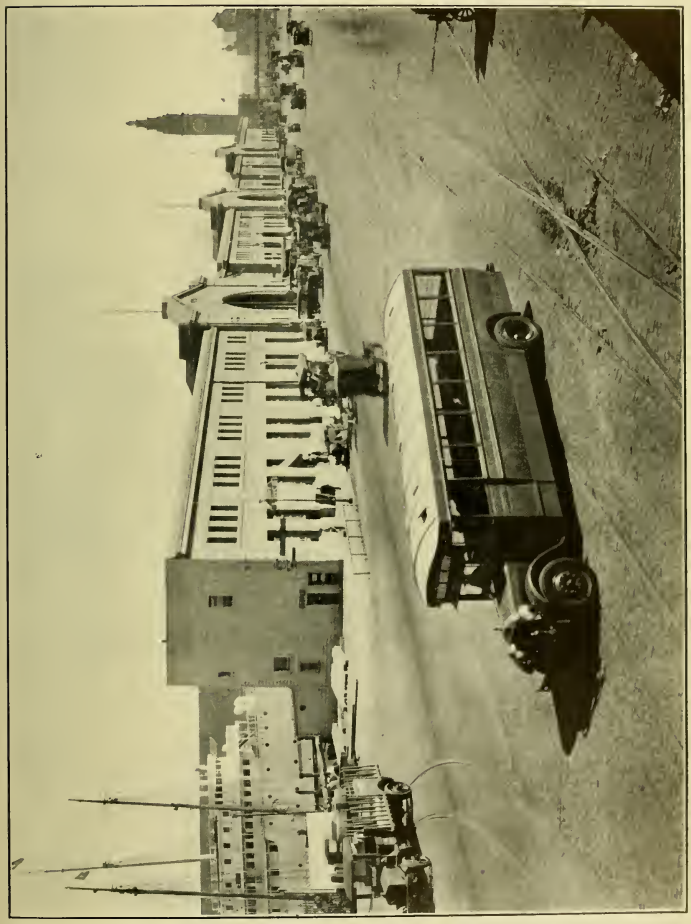
Practically all of the material for this line has been purchased, and on June 29, 1927, bids were received for constructing and erecting concrete trolley poles. Specifications covering the remainder of the work, including overhead trolley wire construction, track construction, and bonding, have been prepared, and contracts for these portions of the work will be awarded in proper sequence, with a view to completing the extension as soon as practicable after the completion of the Sunset Tunnel. It is expected that the track will be ready for service about the end of this year, but the failure of the bond issue to pass will mean deferring the acquisition of adequate equipment and car housing facilities, and may hamper the City in operating the line. The Supervisors are being urged to provide money with which to make it possible to give a reasonably adequate service on the completion of the line.

Embarcadero Bus Line:

The history of this line up to the receiving of bids for furnishing the equipment, has been covered in the last annual report. As stated in that report, progress for the time being was halted on account of legal complications following the award as made by the Board of Public Works.

On July 21, 1926, under Resolution No. 92781, the Board of Public Works made a fresh start by rescinding their previous award and adopting Resolution No. 92782, in which they requested authority from the Supervisors to purchase the buses in the open market. This authority was granted by Ordinance No. 7268, following which the Board of Public Works, by Resolution No. 94539, adopted November 8, 1926, ordered the purchase of the following buses, all seating 29 passengers:

2 White buses	at	$8,211.00	$16,422.00
2 Fageol 6 cylinder buses	at	9,462.50	18,925.00
2 Mack 4 cylinder buses with "Duralyte" body	at	9,470.44	18,940.88
Total			$54,287.88



MUNICIPAL RAILWAY—BUS ON EMBARCADERO LINE

On January 27, 1927, at noon, service on the Embarcadero was inaugurated between the Golden Gate Ferry slip at the foot of Hyde Street, and the Southern Pacific Company's station at Third and Townsend Streets.

The operating results to date seem to verify the unfavorable predictions made at various times by this office. However, under an agreement embodied in Resolution No. 25351 of the Board of Supervisors, these losses up to $18,000 per year will be borne by the Harbor Commission, and it is expected that this subsidy will approximately cover them.

Car Shops and Garage:

Another unfortunate result of the June bond election is that the Municipal Railway must for the time being operate without adequate shop and garage facilities. The urgent need of these has been pointed out in previous reports, but the railway, with mileage and equipment greatly increased, is still struggling along with its original shop facilities. In the matter of the garage, the situation is desperate and some provision must be made for the railway's growing fleet of buses and other automotive equipment. The railway, starting with no buses at all, now operates 19 of these vehicles. Under present conditions not only are the buses when not in service at night required to stand outdoors, exposed to the elements, but the mechanics and maintenance men are obliged to work on these buses on the public streets in all kinds of weather, a condition which is almost intolerable.

Equipment:

During the year, contracts were awarded for fifteen new street cars of the type now in use by the Municipal Railway. All of these cars have been delivered, and are being put in service as rapidly as they can be assembled and tested. The new cars are in general the same as the 125 cars purchased in 1914 for approximately $7,000 each. The contract price on the new cars is $18,316.30, to which must be added the cost of inspection, unloading, assembling, and overhead. This increase in cost between 1914 and 1927 is only a concrete illustration of why railroad costs are mounting.

d	Amount Expended to June 30,1927	FUNDS
Saturn St., Ord Terrace. (Pa 84	$ 10,000.00*	General Fund and Public Assessment
Kearny St., Mai (Widening) 69	17,128.69	General Fund
Union St., Fra 51	15,939.51	General Fund
Virginia Ave., (Paving, wal 76	6,469.74*	General Fund and Public Assessment
Clement St., Ai (Widening) 46	4,700.00*	General Fund and Property Owners
Fillmore St., C 55	22,478.55	County Roads
Bluxome St., 4 08	22,264.08	General Fund and County Roads
Stanyan St., Fu (Paving) 74	10,984.74	County Roads
Douglass St., 66 (Paving, wal	9,000.00	County Roads and Public Assessment
Peralta St., Y Tomasa St., Pe 10 (Paving, wal	6,150.00	General Fund and Public Assessment
Market St. Exte (Contract #3 6	51,000.00	County Roads
Telegraph Hill 68	13,744.68	County Roads
Mt. Vernon Ave. Mt. Vernon A 0	2,152.00	County Roads
Elk St., Boswor (Grading) 28	1,800.00	General Fund
Geneva Ave., Pa line. (Pavi 28	21,685.28	County Roads
Golden Gate He 73		Public Assessment
Elizabeth St., 23 (Paving, wal		General Fund and Public Assessment
Turk St., Mason 26		County Roads and Public Assessment
Southern Height Carolina St. 43	7,591.43	County Roads
Masonic Ave., C 73	2,481.73	County Roads
Castro St., 29t 30th St. ely.f 0	8,250.00	County Roads
Grand View Ave. (Grading, wal 5		County Roads

* Balance

DESCRIPTION	CONTRACTOR	Date of Award	Date Completed	Per Cent Completed	Amount of Completed Contract	Amount Expended to June 30,1927	FUNDS
BOULEVARDS, PAVING, AND GRADING							
Saturn St., Ord St. to Lower Terrace. (Paving,walls, etc.)	Jas. M. Smith	8/17/25	8/ 9/26	100	$ 19,363.84	$ 10,000.00*	General Fund and Public Assessment
Kearny St., Market St. to Columbus Avenue (Widening)	City Construction Co.	10/23/25	9/28/26	100	17,128.69	17,128.69	General Fund
Union St., Franklin to Steiner St. (Widening)	C. B. Eaton	12/11/25	9/28/26	100	15,939.51	15,939.51	General Fund
Virginia Ave., Eugenia Ave. to Winfield St. (Paving, walls, etc.)	C. B. Eaton	1/ 4/26	2/16/27	100	10,854.76	6,469.74*	General Fund and Public Assessment
Clement St., Arguello Blvd. to Funston Ave. (Widening)	Frank J. McHugh	1/22/26	12/28/26	100	10,685.46	4,700.00*	General Fund and Property Owners
Fillmore St., Cervantes to Marina Blvd. (Paving)	Pacific States Construction Co.	4/ 9/26	10/ 8/26	100	22,478.55	22,478.55	County Roads
Bluxome St., 4th to 6th St.(Reconstruction)	A. E. Hennessey	6/ 4/26	4/13/27	100	22,264.08	22,264.08	General Fund and County Roads
Stanyan St., Fulton to McAllister St. (Paving)	Municipal Construction Co.	7/16/26	11/23/26	100	10,984.74	10,984.74	County Roads
Douglass St., 20th to 21st St. (Paving, walls, etc.)	Keystone Construction Co.	7/17/26	3/30/27	100	35,380.66	9,000.00	County Roads and Public Assessment
Peralta St., York St. to Holladay Ave. and Tomasa St., Peralta to Montcalm St. (Paving, walls, etc.)	M. J. Treacy	8/ 9/26		75	33,126.10	6,150.00	General Fund and Public Assessment
Market St. Extension, Mono to Ord St., Section B, (Contract #1, Paving, walls, etc.)	Jas. M. Smith	8/20/26		70	102,566.36	51,000.00	County Roads
Telegraph Hill Blvd.,Contract #2 (Paving)	Keystone Construction Co.	9/ 8/26	2/28/27	100	13,744.68	13,744.68	County Roads
Mt. Vernon Ave. Extension, Harold Ave. to Mt. Vernon Ave. (Grading)	Granfield, Farrar and Carlin	9/ 8/26	3/ 2/27	100	2,152.00	2,152.00	County Roads
Elk St., Bosworth to Chenery St., Contract #1 (Grading)	Eaton and Smith	9/17/26		100	2,283.28	1,800.00	General Fund
Geneva Ave., Prague St. to San Mateo County line. (Paving)	Fay Improvement Company	9/17/26	3/14/27	100	21,685.28	21,685.28	County Roads
Golden Gate Heights (Grading,walls,etc.)	A. E. Hennessey	9/22/26			455,418.73		Public Assessment
Elizabeth St., Hoffman Ave. to Burnham St. (Paving, walls, etc.)	T. M. Gallagher	9/22/26		95	13,639.23		General Fund and Public Assessment
Turk St., Masonic to Parker Ave. (Paving)	A. E. Hennessey	10/27/26			45,828.26		County Roads and Public Assessment
Southern Heights Ave., Rhode Island to Carolina St. (Paving)	Fay Improvement Company	11/15/26	5/18/27	100	7,591.43	7,591.43	County Roads
Masonic Ave., Oak to Fell St. (Paving)	Pacific States Construction Co.	12/29/26	3/ 8/27	100	2,481.73	2,481.73	County Roads
Castro St., 29th to 30th St., and 30th St. ely.from Castro (Grading,walls,etc.)	Jas. M. Smith	2/ 4/27		90	11,618.90	8,250.00	County Roads
Grand View Ave., Elizabeth to Stanton St. (Grading, walls, etc.)	Schultz Construction Co.	3/18/27		20	59,437.35		County Roads

* Balance paid by property owners.

	Dof ed t	Amount Expended to June 30,1927	FUND
San Jose Ave.,	2.09	$ 3,750.00	County Roads
Gilbert St. an Brannan St.	2.05	6,022.05	General Fund
Great Highway, Ulloa St. (R	8.00	4,558.00	County Roads
Great Highway, Sly. termina	5.85		County Roads
6th St.Bridge,	5.00	1,845.00	General Fund
Sunset Tunnel	9.00)	696,755.10	Assessment Fund
Safety Zone Bu	5.95	2,082.50	General Fund
City Lands, Do (Grading and	8.20	9,838.20	General Fund
Street Signs,	2.84	8,932.84	General Fund
Auxiliary Wate District, Hi	2.21	43,672.21	General Fund
Pulgas Prevent	0.87	12,870.87	General Fund
Sutro Monument	2.27	13,750.00	General Fund
Safety Lane Mar	8.19	3,930.00	General Fund
Water Mains,Br Mansell Sts.	4.75	3,384.75	Property Owners
San Francisco (Grading -fil	0.20	16,080.20	General Fund
Contract #2,	6.63	8,800.00	General Fund
Contract #3,	3.96	8,353.96	General Fund
Contract #4,	4.60	11,250.00	General Fund
Contract #5,	0.45	3,210.00	General Fund
Contract #7,	6.20		General Fund
Westerly Sunse 43d Avenue M	5.26	60,925.26	General Fund
Westerly Sunse 43d Avenue M	0.50	36,450.00	General Fund
Westerly Sunse Santiago Str	9.42	72,369.42	General Fund
Islais Creek I	4.47	2,614.47	General Fund
Fleishhacker P	4.00		General Fund
Sunny Dale Ave	7.00	4,317.00	General Fund
Canal St. Sewe	6.00		General Fund
Stanley St. Se Junipero Ser	3.79		General Fund
Noriega St. Se	0.00	6,000.00	General Fund

Contract amou

DESCRIPTION	CONTRACTOR	Date of Award	Date Completed	Per Cent Completed	Amount of Completed Contract	Amount Expended to June 30,1927	FUND
BOULEVARDS, PAVING, AND GRADING							
San Jose Ave., Gorham to Cotter St.(Widening)	Chas. L.Harney	3/23/27		80	$ 7,222.09	$ 3,750.00	County Roads
Gilbert St. and Harriet St., Bryant to Brannan St. (Reconstruction)	Eaton and Smith	3/25/27	5/10/27	100	6,022.05	6,022.05	General Fund
Great Highway, Wly. one-half, Taraval St. to Ulloa St. (Paving)	Municipal Construction Co.	3/30/27	6/ 8/27	100	4,558.00	4,558.00	County Roads
Great Highway, Wly. one-half, Ulloa St. to Sly. termination (Paving)	L. J. Cohn	4/ 6/27			10,555.85		County Roads
MISCELLANEOUS							
6th St.Bridge, Revolving Carriage (Repair)	Wm. Speck	4/ 9/26	7/20/26	100	1,845.00	1,845.00	General Fund
Sunset Tunnel (Duboce Ave. Route)	Youdall Construction Co.	5/10/26		75	(1,297,699.00)	696,755.10	Assessment Fund
Safety Zone Buttons (Installation)	E. J. Treacy	6/ 2/26		50	4,255.95	2,082.50	General Fund
City Lands, Douglass at 26th St. (Grading and Fence)	C. B. Eaton	7/15/26	1/25/27	100	9,838.20	9,838.20	General Fund
Street Signs, Contract #6	Schultz Construction Co.	8/ 6/26	1/20/27	100	8,932.84	8,932.84	General Fund
Auxiliary Water Supply System, Butchertown District, High Pressure Mains	Schultz Construction Co.	9/ 3/26	6/29/27	100	43,672.21	43,672.21	General Fund
Pulgas Preventorium Water Supply	Ajax Construction Co.	9/27/26	3/30/27	100	12,870.87	12,870.87	General Fund
Sutro Monument & Grounds (Improvement)	Eaton and Smith	10/ 5/26		100	13,932.27	13,750.00	General Fund
Safety Lane Markers,Contract #2 (Installation)	L. M. Neil	1/12/27		100	5,308.19	3,930.00	General Fund
Water Mains,Brussels, Coettingen,Ordway, and Mansell Sts. (Furnishing and installation)	Eaton and Smith	2/ 4/27	5/10/27	100	3,384.75	3,384.75	Property Owners
San Francisco Municipal Airport: Contract #1, (Grading -filling depressions)	Granfield, Farrar and Carlin	3/18/27	5/18/27	100	16,080.20	16,080.20	General Fund
Contract #2, Water Service, Drainage and Marking	Latourrette, Fical Company	4/ 1/27		98	9,366.63	8,800.00	General Fund
Contract #3, Administration Building	Elliott and Grant	4/ 1/27	5/10/27	100	8,353.96	8,353.96	General Fund
Contract #4, Hangar #1	Roy Lind	4/ 8/27		65	23,664.60	11,250.00	General Fund
Contract #5, Hangar and Field Lighting	Latourrette, Fical Co.	4/ 8/27		60	7,120.45	3,210.00	General Fund
Contract #7, Floodlight,Housing and Meteorological Stations	F. W. Varney	5/13/27		50	1,576.20		General Fund
SEWERS							
Westerly Sunset District Sewer, Section "A" 43d Avenue Main	C. B. Eaton	4/ 9/26	3/29/27	100	60,925.26	60,925.26	General Fund
Westerly Sunset District Sewer, Section "B" 43d Avenue Main	Frank J. McHugh	10/15/26		30	155,860.50	36,450.00	General Fund
Westerly Sunset District Sewer, Section "C" Santiago Street Main	L. J. Cohn	4/23/26	4/ 5/27	100	72,369.42	72,369.42	General Fund
Islais Creek Drainage Culvert	Healy,Tibbitts Construction Co.	10/ 1/26	1/25/27	100	2,614.47	2,614.47	General Fund
Fleishhacker Playfield Sanitary Sewer	L. J. Cohn	5/20/27			3,054.00		General Fund
Bunny Dale Avenue Sewer,Schwerin to Hahn St.	E. C. Moran	2/ 2/27	5/24/27	100	4,317.00	4,317.00	General Fund
Canal St. Sewer Extension, Contract #3	Jas. M. Smith	6/17/27			3,746.00		General Fund
Stanley St. Sewer Extension, Charles Ave. to Junipero Serra Blvd.	Jas. M. Smith	6/17/27			6,833.79		General Fund
Noriega St. Sewer, 24th to 29th Avenue	Manuel Smith	2/18/27		100	11,240.00	6,000.00	General Fund

Contract amounts in parenthesis (--) are based on estimated quantities.

		D	Amount Expended to June 30,1927	FUND
149A	Street Ca	5	$121,050.00	Mun. Ry. Depreciation
149B	Street Ca	8	14,137.50	Mun. Ry. Depreciation
149C	Street Ca	0	69,425.34	Mun. Ry. Depreciation
149D	Street Ca	4	6,896.64	Mun. Ry. Depreciation
150A	Track Mat	0	80,662.20	Mun. Ry. Depreciation
150B	Track Mat	0	12,355.50	Mun. Ry. Depreciation
150C	Track Mat	0	7,130.50	Mun. Ry. Depreciation
150D	Track Mat	0		Mun. Ry. Depreciation
150E	Track Mat	0	1,860.00	Mun. Ry. Depreciation
150F	Track Mat	0	315.00	Mun. Ry. Depreciation
150G	Track Mat	0	244.00	Mun. Ry. Depreciation
150H	Track Mat	5	1,581.75	Mun. Ry. Depreciation
151	Wood Ties	1	29,499.21	Mun. Ry. Depreciation
152	Track Spe	0		Mun. Ry. Depreciation
153	Copper Tr	2	4,663.92	Mun. Ry. Depreciation
156A	Electric	0)		Mun. Ry. Depreciation
156B	Electric	8)		Mun. Ry. Depreciation
156C	Electric	9)		Mun. Ry. Depreciation
157	Undergrou	0		Mun. Ry. Depreciation
	Contract			

	DESCRIPTION	CONTRACTOR	Date of Award	Date Completed	Per Cent Completed	Amount of Completed Contract	Amount Expended to June 30,1927	FUND
		MUNICIPAL RAILWAYS						
149A	Street Car Bodies	St. Louis Car Co.	11/26/26		60	$241,702.75	$121,050.00	Mun. Ry. Depreciation
149B	Street Car Trucks	J. G. Brill Co.	8/25/26		60	47,249.38	14,137.50	Mun. Ry. Depreciation
149C	Street Car Motor Equipment	Westinghouse Electric & Manufacturing Co.	8/ 6/26		60	154,892.00	69,425.34	Mun. Ry. Depreciation
149D	Street Car Air Brake Equipment	Westinghouse Traction Brake Co.	10/ 1/26		60	15,190.94	6,896.64	Mun. Ry. Depreciation
150A	Track Materials,Girder rail & fastenings	U.S.Steel Products Co.	12/ 1/26		99	80,941.70	80,662.20	Mun. Ry. Depreciation
150B	Track Materials,Tee rail and joints	Bethlehem Steel Co.	12/ 1/26	4/ 2/27	100	12,355.50	12,355.50	Mun. Ry. Depreciation
150C	Track Materials,Tie plates	U.S.Steel Products Co.	12/ 1/26	2/19/27	100	7,130.50	7,130.50	Mun. Ry. Depreciation
150D	Track Materials,Track bolts	Bethlehem Steel Co.	12/ 1/26		94	2,239.00		Mun. Ry. Depreciation
150E	Track Materials,Track spikes	Bethlehem Steel Co.	12/ 1/26	3/ 9/27	100	1,860.00	1,860.00	Mun. Ry. Depreciation
150F	Track Materials,Anti-creepers	P. & M. Co.	12/ 8/26	4/26/27	100	315.00	315.00	Mun. Ry. Depreciation
150G	Track Materials,Lock washers	F. Bodler	12/26/26	5/ 7/27	100	244.00	244.00	Mun. Ry. Depreciation
150H	Track Materials,Tie rods	Kortick Mfg. Co.	12/ 3/26	2/17/27	100	1,581.75	1,581.75	Mun. Ry. Depreciation
151	Wood Ties	H. L. Kell	12/13/26	6/ 7/27	100	29,499.21	29,499.21	Mun. Ry. Depreciation
152	Track Special Work	U.S.Steel Products Co.	2/25/27			42,897.10		Mun. Ry. Depreciation
153	Copper Trolley Wire	Standard Underground Cable Co.	2/25/27	4/13/27	100	4,663.92	4,663.92	Mun. Ry. Depreciation
156A	Electric Cables, lead covered	American Brass Co.	6/ 3/27			(10,035.60)		Mun. Ry. Depreciation
156B	Electric Cables, rubber insulated	Standard Underground Cable Co.	6/ 3/27			(2,177.98)		Mun. Ry. Depreciation
156C	Electric Cables, weatherproof and bare	Pacific States Electric Co.	6/ 3/27			(8,695.19)		Mun. Ry. Depreciation
157	Underground Conduit Material	Graybar Electric Co.	6/17/27			6,015.20		Mun. Ry. Depreciation

Contract amounts in parentheses (--) are based on estimated quantities.

HETCH HETCHY WATER SUPPLY

Progress and Development

The fiscal year July, 1926, to June, 1927, was a year of steady progress in new construction and of successful and profitable operation of the completed units of the Hetch Hetchy Water Supply System. The year's record includes no outstanding events of primary importance.

In the **Foothill Division,** very satisfactory progress was made in the work of aqueduct tunnel construction. At the beginning of the fiscal year, tunnel excavation was under way in eight headings from four construction camps. A little later, work was commenced at the two portals camps, Moccasin and Oakdale. The total excavation during the year in the ten headings was 45,112 linear feet of tunnel, and the total from commencement of construction to the end of the year was 47,947 feet, which is 57 per cent of the total length of tunnel in the division. At the close of the year excavation was in progress in nine headings, the short one east from Pedro Adit having holed through to the Tuolumne Canyon.

At each of the six camps the work was commenced by City forces. During the year two contracts were awarded covering the work in five headings, about seven miles in all, and three camps were turned over to the contractors. The wisdom of this policy has been borne out by the results; the initial work by the City insured reasonable bids by the contractors, without undue allowance being made for contingencies, a spirit of competition is encouraged between the City's and Contractor's forces working in adjacent sections, and a direct comparison of costs under the two plans is made possible.

A new record for one month's progress in excavation for all of the Hetch Hetchy Water Supply tunnels was established in March, 1927, in the Hetch Hetchy Junction east heading—781 feet.* The previous record was 776 feet in the Priest heading, in August, 1921.

Preliminary work in connection with the construction of the downstream dam and other features of the Moccasin Reregulating Reservoir was in progress at the close of the year, under day labor.

In the **Coast Range Division,** between the San Joaquin Valley and Irvington, final location surveys were run, portions of the necessary lands and rights of way were acquired, and construction of roads, camps, electric power transmission lines, telephone lines and camp water systems was begun. The sinking of the shaft at Arroyo Mocho was commenced.

This division includes 28.6 miles of tunnel work and six-tenths mile of pipe. Five shafts are required, ranging from 289 feet to 804 feet in depth. On December 14, 1925, the City Engineer submitted to the Board

---

*This record was itself broken in September, 1927, in the same heading, the new figure being 803 feet, which also establishes a new United States record for such work.

of Public Works a budget of proposed Hetch Hetchy Water Supply expenditures in the total amount of $8,027,554 including $1,502,554 for preliminary work and shafts in the Coast Range. This was immediately transmitted to the Board of Supervisors, who withheld approval of the proposed Coast Range work while approving the remainder of the budget. On October 4, 1926, a budget for $1,502,554 for Coast Range work was submitted. This was approved five months later, on March 5, 1927 —nearly sixteen months after the date of the budget first mentioned. Thus there has been considerable unnecessary delay, but for which the Coast Range shaft work would now be much further advanced.

The **Moccasin Power Development**, first placed in regular service August 14, 1925, has been in continuous successful operation since that date, delivering electric power over the City's transmission line to Newark for distribution under the contract between the City and the Pacific Gas and Electric Company. For the fiscal year 1926-1927, the net earnings of the system, available toward payment of bond interest and redemption charges, amounted to about $1,850,000, and the corresponding figure for the entire period of operation, 22½ months, is over $3,600,000.

The **Bay Development** of the Hetch Hetchy aqueduct, extending from Irvington to Crystal Springs Reservoir, has been operated by the Spring Valley Water Company at full capacity of the pumps, under the agreement of 1922, since May 21, 1926. Under the terms of this agreement the City receives an annual rental of $250,000 from the Company for the use of the aqueduct. The total amount accrued to the City's credit on this account at June 30, 1927, was $329,055. This figure includes compensation for use of the aqueduct at part capacity previous to May 21, 1926.

Present Condition of the Project

The status on June 30, 1927, of the project as a whole is briefly summarized below:

The Hetch Hetchy and Lake Eleanor Reservoirs, the aqueduct between Early Intake and Moccasin Creek (21.1 miles), the Priest Reservoir, the Moccasin Power Plant, and the transmission line from Moccasin to Newark are completed as to the initial stage of development, and are in service in connection with hydro-electric power development. The reservoirs and power plant will be increased in capacity and a parallel transmission line will be built when necessary.

The first Bay Crossing Pipe Line and the Pulgas Tunnel, extending from Irvington to Crystal Springs Reservoir (21.8 miles), are completed and in service for delivery of water from Alameda County sources to the San Francisco peninsula, pending the completion of the Hetch Hetchy Aqueduct. The result of this operation has been to raise the level of the Crystal Springs Reservoir 27 feet during the past year in spite of consumption draft.

The Foothill Division aqueduct construction (16.3 miles) between Moccasin Creek and Oakdale Portal is well advanced and making rapid progress.

Work in the Coast Range preliminary to shaft sinking is in progress, and the sinking of one shaft has been commenced.

Right of way in the San Joaquin Valley has been acquired for about 36 miles of the San Joaquin pipe line, out of a total length of about 47 miles.

The bond issue of 1925, under which the present tunnel construction work is financed, will cover the Foothill Division work and the shaft work in the Coast Range. To complete the Coast Range tunnels, to build the San Joaquin pipe line between Oakdale Portal and Tesla Portal and to build the short pipe line to connect Irvington Portal of the Coast Range tunnels to the east end of the existing Bay Crossing Pipe Line, additional funds to the extent of about $24,000,000 will be required. In order to avoid delay to the work by cessation of construction a new bond issue must be authorized early in the year 1928.

The aqueduct will be completed during 1932, unless there is serious delay due to lack of funds or other causes beyond the control of the construction force.

Organization and Headquarters Work

The Hetch Hetchy Water Supply work is carried on under the general direction of M. M. O'Shaughnessy, City Engineer. Nelson A. Eckart, Chief Assistant Engineer, exercises direct supervision over all the work.

City Headquarters Office:

The City office staff lays out and designs all projected work, prepares plans and specifications for all work done, selects and purchases equipment for day labor work, prepares maps and descriptions of lands and rights of way to be purchased, and checks and passes for payment all bills and payrolls. The staff personnel includes: R. P. McIntosh and L. W. Stocker, Civil Engineers; P. J. Ost, Electrical Engineer; E. P. Jones, Mechanical Engineer; H. W. Kephart, Purchasing Agent; J. J. Phillips, Right of Way Agent; and a number of assistant engineers, draftsmen and clerical employees.

Some of the more important items of City office work done during the past year are mentioned below:

Designs were in preparation for the dam and appurtenant structures for the Moccasin Reregulating Reservoir and the intake tower at the Moccasin Portal of the Foothill Division Tunnels.

At the request of the Board of Supervisors, new studies were made and estimates prepared for the purpose of determining the relative costs and suitability of pipe lines over the Coast Range as against the proposed aqueduct tunnels. The superiority of the tunnel plan was demonstrated.

The final location and gradient of the Coast Range Tunnels were established and a construction program for this division of the work was formulated.

Plans and specifications were prepared for the following contracts:

No. 113, for the construction of aqueduct tunnels in the Foothill division.

No. 114, for wrought steel pipe for air lines in Foothill Division Tunnels.

No. 115, for cedar poles for the electric transmission line to serve the Coast Range Division construction work.

No. 116, for copper wire for the electric transmission line to serve the Coast Range Division construction work.

No. 117, for insulators and pins for the electric transmission line to serve the Coast Range Division construction work.

No. 118, for sub-station equipment for Seco Sub-station in the Coast Range division.

Appended to this report is a tabulation of detail data on current contracts for the year 1926-1927.

In connection with the acquisition of lands and rights of way the City office staff prepares descriptions for deeds, leases, decrees and other documents and maintains records of acquisitions. Maps for court cases are also prepared. During the latter part of the fiscal year considerable work was done on the preparation of maps and documents in connection with acquisition of land and rights of way for the aqueduct and for related purposes in the Coast Range Division.

Final record right of way maps and deed books were completed for the Bay Crossing Division and were in course of compilation for the San Joaquin Division. This work is part of a program designed to establish and preserve, in an orderly, simple and complete form, for convenient reference, all records pertaining to real estate transactions on the Hetch Hetchy Water Supply project. In addition to maps and deed books for each division, a tabulated "deed list" will be made.

The final record maps show all property ties used in deed descriptions, portions of realty subdivisions in the vicinity of the City's rights of way, relation of surveys where more than one survey has been made, and sufficient topography to permit ready identification of the property. Each piece of land owned or controlled by the City is marked on the maps with an index reference number. These numbers, arranged according to divisions to form a complete series, are assigned to each deed or other document and provide a rapid and easy reference between maps, deed books and deed lists.

In the deed books are filed true copies of all deeds arranged in the numerical order of their index reference numbers. Added to these copies of deeds is a reference to right of way maps showing the land described, a reference to title reports, and the recordation data. Deeds are contained in convenient binders which are filed in numerical order in drawers and marked conspicuously for identification. Title reports are filed in the same manner as deeds but no map or other reference is marked on the reports.

The deed lists contain in tabular form for each transaction the parcel reference number for the deed or other document; map reference; brief description of location; the names of parties to the transaction; the number of the Board of Supervisors resolution authorizing the transaction; description, date and recordation of documents; consideration involved in the transaction; the area and statement of nature of the land, and a brief summary of important conditions contained in the document. Thus the lists present in concise form a full story of each transaction, and give without referring to the deed book, practically all information ordinarily required as to conditions.

The use of the final records involves but little previous knowledge of the system and the project, it being only necessary to know the division in which any transaction has taken place to find the full story of that transaction. Knowing the location of the parcel of land in question, the method of approach to a full story of the transaction is to locate this parcel on the map from which the parcel reference number is taken. With this number the deed is easily procurable or the story is found in condensed form on the deed lists. Knowing only the names of parties to a sale of land, the full story is revealed by reference to alphabetical indexes in the deed book from which parcel reference numbers are taken, and with these the particulars are obtained from the deed lists and maps, or the deed books if more detail is required.

A set of maps and profile drawings of the constructed Bay Crossing Pipe has been completed. These drawings, designed to be used for operation and maintenance purposes, show construction details, location and size of fittings, and the pipe line survey line in detail, in addition to the usual information shown on maps and profiles. They are particularly intended for use in connection with the operation and maintenance of the aqueduct and the planning of future additional construction, such as parallel pipes to obtain increased aqueduct capacity and branch lines to supply water to districts adjacent to the aqueduct, as well as for general reference.

Final record detail plans for various constructed units of the system are in preparation. Generally the original plans prepared before or during construction serve also for final record purposes, either without change or with revisions that do not require replacement of the whole drawing. In many instances, however, new drawings are required in order to preserve, in permanent form and properly coordinated, plans originally drawn up piecemeal and hurriedly on tracing paper to meet the exigencies of construction as they arose.

Field Headquarters:

Headquarters for the Foothill Division continues at Hetch Hetchy Junction with L. T. McAfee, Construction Engineer, in charge. A number of items of work in the Mountain Division were also carried out under Mr. McAfee's supervision.

The Bay Development work, under the direction of C. R. Rankin, Construction Engineer, located at Palo Alto, was completed in the first two months of the fiscal year. In October, 1926, Mr. Rankin was placed in charge of field work in the Coast Range Division, with headquarters at Livermore. Some of the men serving under him on the Bay Development were transferred with him, and they, with the men previously engaged on the Coast Range preliminary work and some additional men later employed, form the present Coast Range Division Headquarters staff.

The accounting work of the Board of Public Works relating to the entire Hetch Hetchy System is centralized in charge of Willis O'Brien, Auditor, with headquarters at Hetch Hetchy Junction.

Field Employees:

The number of employees in the field increased during the fiscal year from 620 at the beginning to 1042 at the end of the year, due to increased operations in the Foothill Division and to the opening up of the Coast Range work. The following table shows the number of men, including the City's field engineering staffs, employed on the various jobs on June 30, 1926, and June 30, 1927:

	June 30, 1926		June 30, 1927	
	Construction	Operation	Construction	Operation
Lake Eleanor Reservoir	.....	1	.....	1
O'Shaughnessy Dam	.....	3	.....	2
Lower Cherry Power System	.....	19	.....	10
Early Intake Diversion Works	.....	2	.....	2
Mountain Division Tunnels	.....	2	.....	....
Priest Reservoir	.....	1	.....	1
Moccasin Headworks	.....	2	.....	2
Moccasin Penstocks	.....	....	.....	2
Moccasin Power House	.....	27	.....	27
Moccasin Reregulating Reservoir	10	....	22	....
Moccasin-Newark Transmission Line	.....	4	.....	4
Hetch Hetchy Railroad (Operation in connection with construction work)	.....	....	23	....
Foothill Div. Aqueduct:				
City forces	431	....	473	....
Contractor's forces	.....	....	307	....
Coast Range Div. Aqueduct	7	....	105	....
Dumbarton Strait Bridge	17	....	.....	....
Dumbarton Submarine Pipe	17	....	.....	....
General and Miscellaneous	71	6	57	4
Totals	533	67	987	55
Totals, construction and operation	620		1042	

Medical Service:

Groveland Hospital: The City continued to maintain at Groveland a fully equipped hospital with a capacity of seventy-five patients. A physician (Dr. J. P. Degnan) still continues in the City service as physician in charge of the medical service and he and three trained nurses constitute the staff of the Groveland Hospital.

Cases treated at the hospital during the past fiscal year were as follows:

Non-hospital cases		125
Hospital cases:		
City employees	254	
Employees of A. Guthrie Co. and Connolly and DeLuca (tunnel contractors)	110	
Outside pay patients	32	
Total hospital cases		396
Total Cases treated		521
Capital operations		77

Average time in hospital for hospital cases, 17.8 days.

First Aid Station: In order to better serve the tunnel camps in the Foothill Division, a first aid station was established at Hetch Hetchy Junction in May, 1927, and a physician was placed in charge under Dr. Degnan's supervision. The physician makes daily trips to the various camps along the aqueduct for examination of men, for treatment and for dressings. Hospitalization cases are removed to the hospital at Groveland. A specially built ambulance mounted on a Dodge automobile chassis has been purchased for this purpose.

Hetch Hetchy Junction Headquarters:

The headquarters for the Foothill Division and all other construction work east of the San Joaquin River is established at Hetch Hetchy Junction. The Construction Engineer and his assistants and the Hetch Hetchy Water Supply Auditor and his accounting force have their offices at this point. The divisional shops and warehouse also are located here.

Practically no changes were made in the personnel of the staff during the fiscal year 1926-1927 and no changes were made in the housing facilities at this headquarters.

Livermore Headquarters:

The town of Livermore in Alameda County is the location of the headquarters for the aqueduct construction in the Coast Range Division.

Negotiations have been commenced for leasing a vacant tract of land in Livermore owned by the Southern Pacific Co. An office building, shops, a warehouse and other buildings comprising a complete headquarters establishment will be constructed on this site.

Watershed Sanitation

The water supply of the Hetch Hetchy System is gathered on the watersheds of the Tuolumne and Cherry Rivers and Eleanor Creek, which have an area of 652 square miles above the two storage reservoirs, Hetch Hetchy and Lake Eleanor, and 61 square miles between reservoirs and intakes, or a total of 713 square miles tributary to the aqueduct. The greater portion of this watershed lies within the boundary of the Yosemite National Park. Although this watershed area is uninhabitable during the winter months, the unlimited use of the land, reservoirs and streams by vacationists, tourists and fishermen (hunting being unlawful in the park) is a menace to the purity of the City's water supply.

The following letter presents the opinion of the Board of Health of the City and County of San Francisco on this subject:

CITY AND COUNTY OF SAN FRANCISCO
Department of Public Health

Central Office
1085 Mission St. October 4th, 1926.

Mr. M. M. O'Shaughnessy,
City Engineer,
San Francisco, Calif.
My dear Mr. O'Shaughnessy:

In accordance with the conference had on the sanitation of the watershed of the Hetch Hetchy supply, it is the opinion of the Board of Health that all fishing and activities other than those of sight seeing should be excluded from the Hetch Hetchy Lakes and that portion of the Tuolumne River from these lakes to Early Intake.

This opinion and recommendation is arrived at following a survey of the region in the interest of public health, not only for the one or two thousand workmen who now are using this water for domestic purposes, but as a policy to be adopted and followed in the interest of public health in general of the citizens of San Francisco who will ultimately be supplied from this source and who will be menaced if free access to these lakes and streams is allowed to campers, fishermen, etc. This privilege is nowhere permitted on a municipal watershed and should be checked at this time rather than attempt to do so at a future period.

Therefore, we earnestly recommend that public notice be given that from and after this date no fishing, camping or other activities will be allowed, excepting that transient permission to allow visitors to the Hetch Hetchy Lakes in accordance with the Raker Act. It is further recommended that if necessary to enforce this regulation arrangements be made to adequately patrol the area in the interest of public health and the prevention of the water borne diseases.

Trusting this will receive your early attention and action, we are

Respectfully,
BOARD OF HEALTH.

By WM. C. HASSLER, Health Officer.
WCH/M

All effort has been made to carry out the recommendations contained in the above letter of the Board of Health. Copies of this letter have been posted conspicuously in view at various places where tourists gather on or near the City's watershed. "No Fishing" signs have been posted and all requests for permits to fish in the City's reservoirs have

been refused. An automobile tourists' camp, described elsewhere in this report, is being established at Mather. This camp is being provided with water supply and sewerage systems by the City at an expense of over $50,000, in consideration of which the National Park Service has agreed to close the camp ground at Canyon Ranch between Mather and Hetch Hetchy. The stream draining the Canyon Ranch vicinity flows into the river above Early Intake and closing of this camp ground is very much desired as a sanitary precaution.

The Director of the National Park Service has concurred in part in the City's restrictive actions and it is hoped that recognition of the gravity of this watershed sanitation problem will bring about a fuller cooperation with the City on the part of the Park Service in this matter.

Although the water from this mountain source is not now used by the people of San Francisco, sanitary control of the watershed is necessary at this time, as the water is actually in use for domestic purposes by over 1000 people, this number comprising the employees and families of employees of the City on the construction and operation of the aqueduct and power plants between Early Intake and Oakdale Portal. Further, there is no reason to encourage laxity now, when greater difficulty would be encountered later in the enforcement of rules necessary to maintain purity of the water supply.

Mather-Harden Lake-Tioga Road

Section 9 (p) of the Raker Act reads in part as follows:

"That this grant is upon the further condition that the grantee (the City) shall . . . build . . . a road along the southerly slope of Smiths Peak from Hog Ranch (Mather Station) past Harden Lake to a junction with the old Tioga Road in section four, township one south, range twenty-one east, Mount Diablo base and meridian . . ."

To commence compliance with the above condition of the Raker Act, as informally requested by the Director of the National Park Service, $6,000 was made available for a survey of this road under the direction of the United States Bureau of Public Roads. This money was appropriated from the Hetch Hetchy funds by Resolution No. 26345 (New Series) of the Board of Supervisors, approved by the Mayor October 27, 1926, and was paid over to the National Park Service. The survey is in progress and when it is accepted and the necessary financial arrangements made this road will be constructed.

Mather Recreation Camp

During the time the Playground Commission has been operating its mountain recreation camp at Mather, the attendance and popularity of this resort have greatly increased. The camp was first opened as a vacation resort in July, 1924. In the season of 1927 the guests registered from the City Office of the Playground Commission numbered 490 and in addition to this number approximately 300 transient guests were accommodated, making a total of about 800 for the season.

To provide better swimming facilities for small children and beginners than is afforded by Mather pond, a small swimming pool is un-

der construction. This pool is concrete lined, 30 feet wide by 60 feet long and varies in depth from 2½ feet to 4½ feet. The work is being done by the City's Hetch Hetchy Water Supply forces at the expense of the Playground Commission.

Automobile Tourist Camp

Automobile tourist travel in the Sierra Nevada has greatly increased in the past several years and the Hetch Hetchy region continues to attract a proportionately greater number of these tourists each year. To provide suitable accommodations for these tourists and in line with the sanitation policy already mentioned, a camp ground is being improved on the City's property in the vicinity of Mather Station.

A portion of the meadow land adjacent to and easterly of the City's sawmill will be used for this camp. The site is quite suitable for the purpose and is well situated with reference to roads and trails and points of interest. O'Shaughnessy Dam is only 9.4 miles from this camp site.

Comfort stations and other conveniences will be provided at this camp. Toward this end the City's forces have been constructing a sewer, a sewage disposal plant and a water supply pipe line during the latter part of the year. The sewer system involved the laying of 2472 feet of 8 inch and 1578 feet of 6 inch vitrified iron stone pipe, and constructing a reinforced concrete septic tank and sewage disposal fields. The camp water supply pipe line about 20,000 feet long, brings water from the Canyon Ranch Creek. A connection from this line supplies water to the Ranger Station at Hog Ranch.

The automobile tourist camp will be open to tourists for the 1928 season.

MATHER RECREATION CAMP SWIMMING POOL
New concrete tank at San Francisco municipal camp

Hetch Hetchy Railroad

As noted in a previous report, the Hetch Hetchy Railroad was withdrawn from service as a common carrier on February 15, 1925, and discontinued regular steam service June 1, 1925.

The service on the railroad during the fiscal year 1926-27 was limited to that necessary to serve the construction work. In general, gasoline motor cars are used for both freight and passenger service of that nature. Steam equipment is resorted to when necessary to haul heavy loads beyond the capacity of the gasoline cars, or to handle large quantities of materials in carload lots in a short time.

In May, 1927, locomotive No. 5 was put in commission to haul materials for the Moccasin diversion flume, new cottages at Moccasin power house, and sewer and water supply systems for the tourist camp at Mather. This service was discontinued on June 30th, 1927.

Locomotives No. 3 and No. 4, with 7 Rodger ballast cars (30 cubic yards capacity), were sold at auction in February.

On June 30, 1927, the rolling stock of the Hetch Hetchy Railroad comprised the following items of equipment:

Steam locomotive 1

No. 5, American, 2-6-2, with superheater, weight on drivers, 100,000 lbs.

Passenger train cars 5

2 coaches, seating capacities 52 and 56.
1 combination coach and baggage car, seating capacity 42.
2 excursion cars (converted flat cars), seating capacity 77 each.

Freight and work train cars 32

1 ballast car, V-bottom, capacity 80,000 lbs., or 30 cu. yds.
2 gondola cars, drop bottom.
10 flat cars, capacity 60,000 lbs.
1 flat car, capacity 80,000 lbs.
2 flat cars, capacity 100,000 lbs.
7 box cars, capacity 40,000 lbs.
1 box car, capacity 50,000 lbs.
4 box cars, capacity 60,000 lbs.
1 snow plow.
1 steam shovel.
2 cabooses.

Gasoline motor cars equipped to run on rails:

Passenger service—12, 23, 25 and 32 passengers 4
Freight service—2 tons each 2
Speeders 3

A small number of steam train cars will be sufficient for all service likely to be required of the Hetch Hetchy Railroad for a number of years. Other cars will be sold as favorable opportunities arise.

O'Shaughnessy Dam

Two men are maintained at this point primarily to operate the valves to regulate the release of water from the Hetch Hetchy Reservoir according to the varying requirements of the Moccasin Power Plant. Their duties also include the protection and maintenance of the City's property and the transportation of supplies to the operator stationed at Lake Eleanor.

In November, 1926, an automatic water stage recording gauge was installed, with house and well beside the Tuolumne River below O'Shaughnessy Dam. The record of height of the water in the river as indicated by this gauge is electrically transmitted to the operator's quarters near the dam and is used in determining the amount of water released from the Hetch Hetchy reservoir.

During the vacation season the dam is visited by many tourists, some coming in their own cars, others by stage from Yosemite Valley. One of the City employees is detailed to explain to such parties the principal features of the dam and reservoir and of the Hetch Hetchy project as a whole. The majority of the visitors come from the San Francisco Bay region, and these talks have been the means of educating many San Francisco people as to the progress and possibilities of their mountain water and power system, the magnitude of the work and the thoroughness with which it is being done.

Lake Eleanor

One man is maintained at Lake Eleanor, who operates the gates for the release of stored waters for the operation of the Lower Cherry Power Plant under the direction of the Chief Operator. He also acts as observer in cooperation with the United States Weather Bureau, and also at regular intervals reads the stream gage at Cherry Valley.

Although the road from O'Shaughnessy Dam to Lake Eleanor is not open to public automobile travel, many tourists visit this dam and reservoir. Approximately 700 persons travel on horseback over this road each season. Excursions are arranged for tourists at Mather Station, where private parties provide saddle and pack animals.

Aqueduct Mountain Division

The Mountain Division of the aqueduct, which embraces the Early Intake Diversion Dam and the aqueduct tunnel to Priest Reservoir, has been in service conveying an average flow of 735 second-feet of 475 million gallons daily since August 14, 1925, when the Moccasin Power Plant started generating electrical energy.

No construction work has been carried on in this division for the past fiscal year. Two men at the Early Intake Diversion Dam and three men on general and miscellaneous work constitute the operating force maintained.

Land holders in the vicinity of the aqueduct between Big Creek Shaft and Priest Portal made claims against the City for the drying up of the springs on their property, alleged by them to be due to the construction of the tunnel in this district. These claims were fully investigated and were adjusted during the past fiscal year.

Moccasin Division

Under this head are included Priest Reservoir, the Moccasin Power Tunnel through the ridge west of the reservoir, the surge tank, the steel penstock pipes and the Moccasin Power House. These units have been in constant operation since August 14, 1925. The work of the fiscal year in this division embraced construction of operating facilities and maintenance.

Additional watershed land in the vicinity of Priest Reservoir was purchased during the fiscal year to prevent any possible contamination of the water in the reservoir resulting from the occupancy of this area, as it included a possible hotel site adjoining the Big Oak Flat Road. The old hotel buildings were destroyed by fire in October, 1926. As a further measure to prevent contamination, a fence was constructed in July and August, 1926, around land adjacent to Priest Reservoir, and an existing diversion dam and tunnel to turn drainage from the watershed were repaired and enlarged in December and January. This dam diverts the waters of Rattlesnake Creek through the tunnel out of the watershed of Priest Reservoir into Grizzly Gulch.

HETCH HETCHY AQUEDUCT, MOCCASIN DIVISION—PRIEST OUTLET GATE TOWER

In this tower are the gates controlling the flow of water to Moccasin Power Plant. Upstream face of Priest Dam in right background

Rights of way were obtained from the United States Government for aqueduct, transmission line and roads, as mentioned later in connection with the Foothill Division.

A road was constructed from the Big Oak Flat Road at Priest westerly to the West Portal of the Moccasin Power Tunnel in September, 1926. This road facilitates transportation to the upper portion of the penstock lines.

The Moccasin Power Plant grounds were completely fenced in the spring of 1927 to prevent stock from straying into the premises. Galvanized steel wire fence was used, with ornamental concrete posts along roads in the vicinity of the power house and with steel posts elsewhere. Gates or cattle guards were constructed in fences at all roads.

The work in this division was done by the City's forces.

Power System

There have been no important new developments during the year in connection with the power system, except for the planning of the Seco Substation and transmission lines to supply power from the Moccasin-Newark transmission lines for the Coast Range aqueduct tunnel construction work. This station and the transmission lines are described later in this report, in the section on the Coast Range undertaking.

Modesto Standby Power Negotiations:

The question of supplying power to the Modesto Irrigation District demanded no small amount of attention during the year. Against the utmost resistance of the City Engineer and over the veto of the Mayor, the Board of Supervisors, by a vote of 15 to 3, on September 20th approved a contract and directed the Board of Public Works to enter into the same with the Modesto Irrigation District directors for supplying electric energy to the District. The three Supervisors voting against the contract were Jesse C. Colman, J. Emmet Hayden and W. H. Harrelson.

The Modesto District and the Turlock District jointly own and operate, in conjunction with the irrigation system, a power plant at Don Pedro. Power from this plant is transmitted to Modesto and from there distributed by the District for all purposes, including municipal, irrigation and drainage use. The District had installed a small steam standby plant, which however, was inadequate to serve as a dependable source of supply in the event of trouble at their hydro plant or with their transmission line. To remedy this condition and to safeguard the water supply for the City of Modesto, which is dependent on electric power for pumping, it was necessary for the directors of the District to connect their distribution system with a reliable power supply for standby service. The Pacific Gas and Electric Company was in a position to render the service but asked for the standard standby rates as fixed by the Railroad Commission. The directors did not desire to pay this charge and turned toward the Hetch Hetchy lines for relief, hoping to get this very valuable service for a nominal sum by attempting to construe certain conditions of the Raker Act so as to permit them to draw power for all purposes

when and as they saw fit, at approximately production cost without reference to standby expense. The Raker Act provides that San Francisco shall supply power for municipal, pumping and irrigation loads at cost, but does not require that energy for ordinary commercial or residence loads be supplied.

A form of contract between the Modesto Irrigation District and the Board of Public Works of the City and County of San Francisco was drawn up by the district officials and the City Attorney of San Francisco and an ordinance directing the Board of Public Works to sign the contract was passed August 30, 1926. This ordinance was returned disapproved by the Mayor September 11, and finally passed over the Mayor's veto September 20, 1926, becoming Ordinance No. 7232.

The contract as drawn restricted the amount of energy to be delivered to that required by the Raker Act and set the initial load as 3000 K. W., for which the District was to pay a minimum monthly charge of $375.00 plus an energy charge of 4.7 mills per kilowatt hour actually consumed.

It was the expectation of the majority of the Irrigation District directors to make use of the connection covered by the contract as a means of securing a desired standby service for their entire system, and not as a continuous supply of power for pumping and municipal purposes as contemplated under the Raker Act.

The minority members of the District Board insisted on securing a definite interpretation of the terms of the contract before entering on the expenditure of a considerable sum of money for the construction of a stepdown station to tap the Moccasin-Newark lines.

On December 22, 1926, a meeting was held in the City Attorney's office in San Francisco at which were present a number of the Modesto directors, some of the citizens of the District, the City Attorney of San Francisco and representatives of the City Engineer of San Francisco. At this meeting it was clearly pointed out that San Francisco was not obligated under the contract to supply power for purposes other than those specified in the Raker Act and that even though the City should desire to take care of all of the District's requirements it could only do so at a very great cost and in violation of the contract now in force with the Pacific Gas and Electric Company for the consignment of the Moccasin power.

Under the program of operation contemplated by the District the annual revenue from the contract with Modesto would be very little, if any, over the $4500 minimum. The Pacific Gas and Electric Company intimated that it would demand that the amount of energy which it is obligated to take delivery of and to account for be reduced by the quantity which San Francisco stood ready to deliver to Modesto, which at the price received through the Pacific Gas and Electric Company would

reduce the City's revenue from that source by over $90,000 per year; or the Company might cancel the existing contract with the City, as under it the City is obliged to consign to the Company all power generated at Moccasin and not used by the City for its own purpose or delivered to others in accordance with the requirements of the Raker Act.

Following this meeting and the resulting discussion of the matter within the District there has been a reorganization of the Board of Directors and some changes in personnel of the operating staff and apparently the plan for the construction of a stepdown station by the District to secure electric power from the Moccasin plant has been abandoned and the District is considering a plan to duplicate the transmission line between Don Pedro Power House and Modesto as a means of securing more reliable electric service.

Power System Operation:

Moccasin Power House has been in continuous successful operation since Aug. 14, 1925. The Construction Power House at Early Intake continued operation under conditions described in previous annual report. Several portions of flume that had been in service since May, 1918, were replaced.

MOCCASIN POWER PLANT, HETCH HETCHY WATER SUPPLY
Power house, clubhouse and west terrace group of permanent cottages for operators

The following tabulation shows the power output of both the Moccasin and Early Intake Plants for the fiscal year:

Moccasin generated	513,295,500	kw.-hrs.
Early Intake generated	12,158,900	"
Power received from Pacific Gas and Electric Tuolumne Circuit	17,000	"
Total Power	525,471,400	kw.-hrs.

The distribution of this power is tabulated below:

Consigned to Pacific Gas and Electric Company at Newark	470,318,400	kw.-hrs.
Delivered to Foothill Construction	8,330,650	"
Delivered to Pacific Gas and Electric Tuolumne Circuit	8,481,000	"
Used on Hetch Hetchy Project Mountain Division	240,500	"
Used at Power Houses	902,855	"
Line and Transformer losses and unaccounted for	37,197,995	"
Total	525,471,400	kw.-hrs.

The details of revenue, operating expenses and income to June 30, 1927, from the commencement of the operation of the Moccasin Plant August 14, 1925, are set forth in the financial statement at the end of this report.

Newark-San Francisco Transmission Line:

While the Bay Crossing Division of the Aqueduct was under construction in 1924-1925, a preliminary survey was made for the extension of the Moccasin-Newark transmission line from Newark across San Francisco Bay, thence south of Mayfield to the hills behind Stanford University; thence along this ridge up the Peninsula east of Crystal Springs and San Andres Reservoirs and the Skyline Boulevard to a proposed substation site on the Spring Valley property near Lake Merced, a total length of 40.5 miles.

The Board of Supervisors by Resolution No. 25191, approved February, 13, 1926, ordered a survey, plans, specifications and cost estimates for stepdown station at San Francisco and a transmission line from Newark to San Francisco, paralleling the present Pacific Gas and Electric Company's lines. This resolution carried no appropriation to cover the cost of the work and on March 15, 1926, Resolution No. 25364 was passed setting aside $20,000 from the Hetch Hetchy Power Operative Fund for this purpose.

On July 13, 1926, Mr. Adolph Uhl as a citizen and taxpayer filed a petition with the Supreme Court of the State of California asking for a writ of mandate to prevent the use of money in the Hetch Hetchy Power Operative Fund for the purpose of extending the power transmission line and demanding that the money in the Fund in excess of operating requirements be used to meet interest and sinking fund charges on the 1910 Hetch Hetchy bonds.

This writ was ordered issued on August 27, 1926, S. F. No. 12161, California Supreme Court, and made it impossible to pay any expenses in connection with the proposed new transmission line except from funds provided from some other source than Hetch Hetchy revenue. Anticipating such an outcome of the suit, the Supervisors on August 13, 1926, by Resolution 25999, appropriated from the General Fund the sum of $5,000 with which to carry out the plans proposed by Resolution No. 25191.

This work was immediately undertaken, a preliminary survey being made from Newark Substation across the marshes and around the lower end of the Bay parallel to the existing lines of the Pacific Gas and Electric Company; thence northwesterly, following in a general way the junction of the dry ground and the marsh land along San Francisco Bay. The line would pass through the easterly section of Redwood City, San Mateo and Burlingame to a point whence it could be extended through South San Francisco to a substation site in Visitacion Valley or to the original site selected adjacent to Lake Merced. The line into Visitacion Valley would have a total length of 37.2 miles.

The ridge route as originally selected by the City Engineer, while somewhat longer, has a number of advantages:

It would be much cheaper to construct due to the fact that for approximately 20 miles the line would run through property now belonging to the Spring Valley Water Company, which upon the purchase of that Company's system will come into the possession of the City.

The location is readily accessible from existing roads and would be very easy to patrol and repair in case of breaks.

The larger portion of the line would be at an elevation of more than 1000 feet above sea level and for this reason would be much less subject to interruptions on account of the fouling of insulators, resulting in more satisfactory service.

The Bay Shore route would involve the construction of extensive tower foundations and the building of a walkway for maintenance and patrol purposes. Both of these would require maintenance, adding to the operating cost.

There is some doubt as to the feasibility of operating a 154,000 volt line in such close proximity to the Bay and fume-producing industrial plants. If such voltage proved unsatisfactory it might be necessary, in order to deliver the same amount of energy into San Francisco at a lower voltage, to construct an additional circuit.

Considerable difficulty is to be expected in securing rights of way through the cities mentioned and there are two or three places along the line where it seems almost impossible to force a way through except at prohibitive cost.

Preliminary surveys for the line were completed early in the Autumn and before proceeding with the more detailed work the Public Utilities Committee of the Board of Supervisors were invited to inspect the preliminary line so as to visualize the difficulties encountered. This they have offered to do but up to this time no further action has been taken and the matter is still in abeyance.

Aqueduct, Foothill Division

The Foothill Division includes the Moccasin Reregulating Reservoir, appurtenant structures, 15.9 miles of aqueduct tunnels extending from this reservoir to the east bank of the Tuolumne River at Red Mountain Bar and from the west bank of the Tuolumne River to Oakdale Portal, and the steel pipe siphon across the Tuolumne River to connect the two tunnel sections. All of the new construction work of the Hetch Hetchy system during the fiscal year, except for the relatively small jobs mentioned elsewhere in this report, was centered in this division.

The beginning of the fiscal year found four of the six construction camps completed at Brown Adit, Pedro Adit, Hetch Hetchy Junction and Rock River, and tunnel driving operations in progress in eight headings. The camps at Moccasin Portal and Oakdale Portal were completed shortly afterward and tunnel work commenced on completion of the portal cuts, on September 18 at Moccasin and November 2 at Oakdale Portal. The short section of tunnel east from Pedro Adit holed through September 29, 1926. The work has been vigorously prosecuted in the remaining nine headings, and the rate of progress has been very gratifying. There have been no serious accidents and no interruptions to the work as a whole, though a few minor interruptions of short duration, due largely to ground water conditions, have occurred in some of the headings. Details as to progress and conditions in the various headings are shown later in this report.

Right of Way Acquisitions:

All rights of way for tunnel and tunnel appurtenances, and lands for camps to be purchased from private parties in this division were either already purchased or the purchase proceedings were in progress at the beginning of the fiscal year 1926-1927. The last right of way parcel to be acquired from a private party, a strip 1.7 miles long, in the vicinity of Hetch Hetchy Junction, was purchased in September, 1926.

A considerable portion of the right of way between Moccasin Creek and the Tuolumne River was secured ten years ago from the Federal Government under provisions of the Raker Act, but as the alignment was changed on final location, application was made to the Government during the past year for right of way along the amended location. Embodied in this amended application, in addition to tunnel right of way, were lands for reservoir protection purposes at Moccasin Creek, lands for campsite and dumping area at Brown Adit, lands for cableway landing and camp purposes on the east bank of the Tuolumne River at Red Mountain Bar, and right of way for a tramway to connect the Red Mountain Bar cableway with Brown Adit. The same application covered also amendment of the aqueduct and transmission line rights of way between Priest Reservoir and Moccasin Creek, and rights of way for road purposes and camp and water supply lines in that vicinity.

The amended application was filed at the Sacramento Land Office on July 22, 1926, and received the approval of the Secretary of Interior on February 3, 1927.

Roads:

As outlined in the last previous report, a considerable amount of road work was necessary to facilitate transportation to and from the several tunnel construction camps in this division. The county road relocation along the west side of Moccasin Reservoir, the road between Moccasin Creek and Brown Adit camp, the short road from the Crimea-Don Pedro county road to Pedro Adit camp, the road from Hetch Hetchy Junction to the Crimea-La Grange county road, and the connecting road between Hetch Hetchy Junction and Rock River Camp were graded and partly surfaced prior to June 30, 1926. The surfacing of these roads has since been completed. A small crew of men has been used occasionally during the past year on maintenance of these roads. Where necessary short sections were resurfaced with crushed rock and during the summer months all roads in the vicinity of camps were regularly sprinkled.

The road between Rock River and Oakdale Portal camps, 3.2 miles long, although usable during the spring and summer of 1926, was not completed until November. A rock surfacing placed on this road during July, August, September and October, 1926, provided a road suitable throughout the year for the needs of the work. This road constructed by the City is the only route for travel to or from Oakdale Portal and a full rock surface was necessary to insure uninterrupted transportation during the rainy season.

Wherever the county or state highways were found to be sustaining excessive wear and tear due to the City's hauling, the City has performed maintenance and repair work on those roads so as to keep them in a condition at least as good as, and generally better, than that existing before the City commenced its hauling. Some such work was found necessary to put county roads in fit condition for heavy hauling before the City started work.

Red Mountain Bar Cableway:

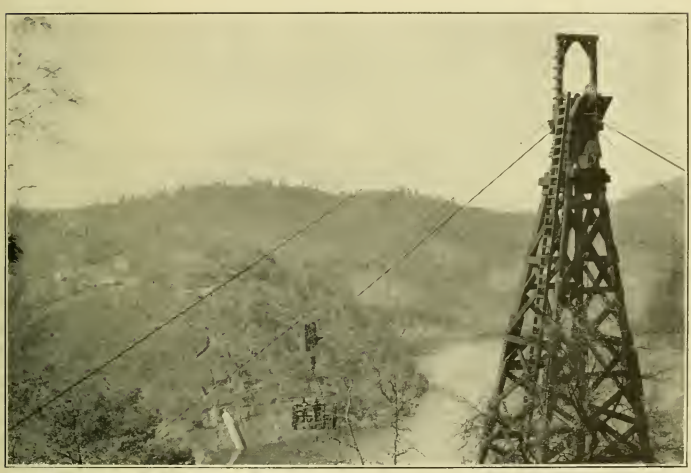
Men, materials and supplies destined to Brown Adit are transported from Hetch Hetchy Junction over the railroad or by road truck to Red Mountain, West Portal, across the Tuolumne River on a Lidgerwood cableway and thence to Brown Adit over a narrow gauge tramway. A very long roundabout truck haul to Moccasin Creek and thence over a summit 1100 feet higher than the adit camp is thus avoided.

The timber towers, anchorages and loading platforms were constructed and the cableway erected by the City's forces during the summer of 1926. The cableway was placed in operation on September 13, 1926.

The clear span of the track cable between towers is 2295 feet. This, it is believed, sets a world's record for length of span for cableways of the hoisting and conveying type ordinarily used on construction work. The head tower on the west bank of the Tuolumne River is 85 feet high with its top at elevation 925 feet and the tail tower is 61 feet high with a

top elevation of 924 feet. These towers, designed in the San Francisco office, are of timber construction with steel tie bolts.

The cableway is designed to carry a 5 ton hook load with ample factor of safety. The conveying speed is 1200 feet per minute and the hoisting speed 300 feet per minute using a 4 part hoisting line. The track cable is 2¼ inches in diameter, of "improved plow steel" grade, with an estimated breaking strength of over 210 tons. The running lines are ¾" plow steel.



HETCH HETCHY AQUEDUCT—RED MOUNTAIN BAR CABLEWAY
Cableway, span 2295 feet, for transporting materials across Tuolumne River Canyon. Concrete-encased steel pipe for Hetch Hetchy Aqueduct is shown passing under Don Pedro Reservoir

Tramway to Brown Adit:

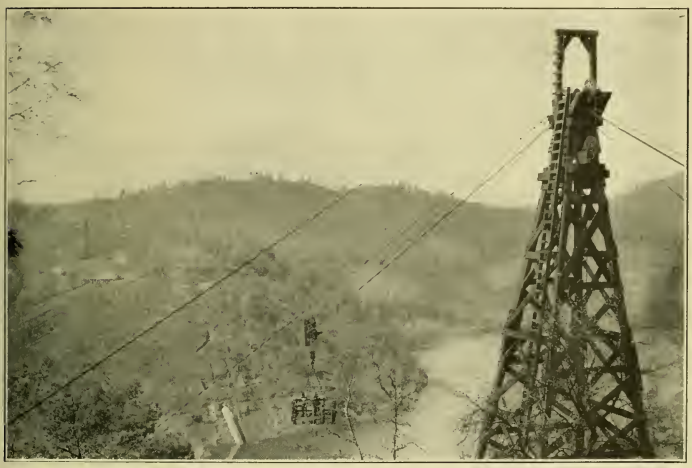
The tramway connecting the east landing platform of the cableway crossing the Tuolumne River and Brown Adit Camp is a light railroad line, 8525 feet long, with a track gauge of 24", the same as used inside the tunnels. A 6 ton Plymouth gasoline locomotive and several special type narrow gauge cars constitute the equipment.

This tramway was built entirely by City forces during the summer of 1926 and was completed August 11, 1926.

The tramway and the cableway were turned over to Connolly and DeLuca, the contractors on the tunnel work east and west from Brown

top elevation of 924 feet. These towers, designed in the San Francisco office, are of timber construction with steel tie bolts.

The cableway is designed to carry a 5 ton hook load with ample factor of safety. The conveying speed is 1200 feet per minute and the hoisting speed 300 feet per minute using a 4 part hoisting line. The track cable is 2¼ inches in diameter, of "improved plow steel" grade, with an estimated breaking strength of over 210 tons. The running lines are ¾" plow steel.



HETCH HETCHY AQUEDUCT—RED MOUNTAIN BAR CABLEWAY
Cableway, span 2295 feet, for transporting materials across Tuolumne River Canyon. Concrete-encased steel pipe for Hetch Hetchy Aqueduct is shown passing under Don Pedro Reservoir

Tramway to Brown Adit:

The tramway and the cableway were turned over to Connolly and crossing the Tuolumne River and Brown Adit Camp is a light railroad line, 8525 feet long, with a track gauge of 24", the same as used inside the tunnels. A 6 ton Plymouth gasoline locomotive and several special type narrow gauge cars constitute the equipment.

The tramway connecting the east landing platform of the cableway of 1926 and was completed August 11, 1926.

This tramway was built entirely by City forces during the summer DeLuca, the contractors on the tunnel work east and west from Brown

Adit, in October, 1926. The contractor will use this equipment and keep it in repair according to the terms of Contract No. 113-E covering the Brown Adit Section of the tunnel work.

Power Transmission Line and Telephone Line:

The work for the past year on the Foothill Division electric power transmission system includes the construction of step-down substations at Moccasin Portal and Oakdale Portal for tunnel construction and at Red Mountain Bar for operation of the Lidgerwood cableway across the Tuolumne River.

The transmission line and substations at the other working points were completed during the fiscal year 1925-1926.

Connections to the telephone line serving all camps in this division were made at the Moccasin Portal camp and at the Red Mountain Bar cableway. At the latter point, in addition to the telephone line a signal line was installed to be used in the operation of the cableway.

Rock Crusher at Moccasin Creek:

To provide crushed rock and sand for concrete for the concrete structures appurtenant to the Moccasin Reregulating Reservoir, for the tunnel intake tower and for the lining of the aqueduct tunnel between Moccasin Creek and the Tuolumne River, a rock crushing and screening plant is under construction at Moccasin Portal. This work is being done by City forces.

The plant and the area for stock piles are located within the area of the proposed Moccasin Reservoir, between the old and new locations of the county road, about 600 feet southeasterly from the aqueduct tunnel portal. Material from the tunnel excavation is crushed, screened and piled at this plant. The cars containing suitable material for crushing are pulled out of the tunnel on a 14 per cent incline to a point well back from the portal where they are switched to a track leading up an inclined trestle, to the new county road. The track then follows the outside edge of this road southwesterly to the bunkers of the crushing plant. Cars are handled on the inclines by electric hoists, and in the tunnel and along the road by electric locomotives.

The crushing plant proper is essentially the same as plants built for similar work in the Mountain Division, but embodies refinements in design and construction to minimize operating expense and delays. The capacity of the plant is 150 cubic yards of rock and 75 cubic yards of sand per eight-hour shift.

Hetch Hetchy Junction Shops:

Shops at Hetch Hetchy Junction handle all repairs to equipment that cannot be taken care of at the various shafts, portals or adits. A crew has been constantly busy during the past year on the repair and upkeep of tunnel equipment. In addition to repair work certain equipment, such as tunnel forms for concrete lining, and concrete mixers previously used

in the construction of the Mountain Division tunnels, has been overhauled and stored in anticipation of future use.

Timber that can be cut in large quantities to standard sizes for tunnel timbering is framed at a mill at this camp and is delivered to other working points along the tunnel ready for erection. Timber for other purposes, such as camp buildings, headframes and headframe bunkers has also been cut and shaped and in some cases partially assembled at this mill.

Tunnel Construction Contracts Nos. 113-C and 113-E:

All work on the Foothill Division Tunnels was done by day labor until the fall of 1926 when two contracts were awarded for carrying out certain portions of the work.

To provide for maximum competition in bidding and flexibility in awarding the contract work, the specifications for the work provided for division into three sections: one east and west from Brown Adit, designated Brown section; the second, east and west from Rock River Shaft, designated Rock River Section; and the third, east from Oakdale Portal, designated Oakdale Section. Bidders were permitted to figure on any single section, two sections, or all sections (according to the amount of work they were prepared to handle), under eight propositions:

Proposition A covered the complete construction of the tunnels in all three sections, including concrete lining except where lining is to be permanently omitted. Proposition B covered the same work but in the Brown Section only. Proposition C covered the same work but in the Rock River and Oakdale Sections only. Propositions D. E. F. G. and H covered the excavation of tunnels and the construction of short sections of concrete lining where ordered by the Engineer to cut off an inflow of water or for other reasons. Construction of extensive continuous lengths of lining was not contemplated under any of these propositions, the work of lining being left to be performed by the City either by day labor or under a separate later contract after completion of the contract work of excavation. Proposition D covered the Brown, Rock River and Oakdale Sections together; E, the Brown Section only; F, the Rock River Section only; G, the Oakdale Section only; H, the Rock River and Oakdale Section together.

The lengths of tunnels to be excavated under the contract in the various sections were estimated as follows:

Brown Section	16,800 feet
Rock River Section	14,000 "
Oakdale Section	7,500 "
	38,300 "
	or 7.25 miles

The entire length of tunnels in this division amounts to 15.85 miles, which leaves 8.6 miles to be excavated by City day labor forces.

Bids were received on this contract on September 15, 1926, from eight contractors, three of whom bid on all propositions. The following table shows the comparison of totals of bids on all propositions:

CONTRACT NO. 113

For the Construction of Aqueduct Tunnels in the Foothill Division

Prop.	1 A. Guthrie & Co Inc. Portland, Ore.	2 W. A. Bechtel Co. San Francisco	3 Smith Bros., Inc. Oakland, Calif.	4 Utah Const. Co. San Francisco
A	$2,327,902.50	$2,642,250.00	$2,307,970.00	$2,740,630.00
B	1,069,950.00	.....	1,054,780.00	1,236,300.00
C	1,257,952.50*	.....	1,322,440.00	1,529,630.00
D	1,953,387.50	.....	2,109,185.00	2,299,750.00
E	830,762.50	.....	907,095.00	949,250.00
F	725,212.50	.....	859,495.00	.....
G	397,412.50	.....	498,895.00	.....
H	1,122.625.00	.....	1,323,490.00	1,365,950.00

Prop.	5 T. E. Connolly & J. M. DeLuca San Francisco	6 Youdall Const. Co. San Francisco	7 Stewart & Welch Construction Co. San Francisco	8 Const. Co. of North America San Francisco
A	.....	.....	$2,367,170.00	$4,160,196.00
B	.....	$1,260,850.00	1,064,675.00	.....
C	.....	1,490,870.00	1,441,727.50	.....
D	.....	.....	1,999,485.00	.....
E	$ 779,745.00*	.....	814,470.00	.....
F	.....	.....	852,980.00	.....
G	349,225.00	.....	449,750.00	.....
H	.....	.....	1,302,080.00	.....

*Contract awarded. See itemized bid following.

Itemized Bids for Contracts Awarded.

CONTRACT NO. 113-C: A. GUTHRIE & CO.

Rock River and Oakdale Sections, Foothill Division Tunnels.

Item No	ITEM	Quantity Estimated	Unit Price Bid	Total
1	Constructing lined tunnel, Section No. 2	2,550 lin. ft.	$70.00	$178,500.00
2	Excavation for lined tunnel, Section No. 2	16,500 "	42.00	693,000.00
3	Permanent timbering for lined tunnel	1,000 "	20.00	20,000.00
4	Constructing unlined tunnel, Section No. 5	2,000 "	50.00	100,000.00
5	Enlargement of tunnel from Section No. 2 to Sec. No. 5	17,400 "	9.50	165,300.00
6	Concrete lining in tunnel excavated by City	2,000 c. y.	14.00	28,000.00
7	Concrete lining in advance of regular lining operations	1,500 c. y.	17.30	25,950.00
8	Additional Excavation in tunnel	500 c.y.	10.00	5,000.00
9	Additional Concrete in tunnel	1,500 c.y.	14.00	21,000.00
10	Excavation of overflow shafts	500 c. y.	10.00	5,000.00
11	Concrete lining in shafts	500 c.y.	20.00	10,000.00
12	Backfill in Rock River shaft below tunnel grade	350 c. y.	1.35	472.50
13	Excavation in open cut	500 c. y.	2.00	1,000.00
14	Backfilling excavation in open cut	100 c. y.	1.00	100.00
15	Concrete in open cut or above ground	100 c.y.	17.00	1,700.00
16	Extra cement	200 Bbls.	3.25	650.00
17	Reinforcing steel	25,000 lbs.	.07	1,750.00
18	Placing metal work furnished by City	1,000 lbs.	.03	30.00
19	Furnishing aggregate for concrete to City	200 c.y.	2.50	500.00
	Total, Contract 113-C			$1,257,952.50

CONTRACT NO. 113-E: T. E. CONNOLLY and J. M. DeLUCA
Brown Section, Foothill Division Tunnels.

Item No	ITEM	Quantity Estimated	Unit Price Bid	Total
2	Excavation for lined tunnel Section No. 2	7,800 lin. ft.	$40.00	$312,900.00
3	Permanent timbering for lined tunnel	1,000 lin. ft	8.00	8,000.00
4	Constructing unlined tunnel Section No. 5	9,000 lin. ft.	47.00	423,000.00
5	Enlargement of tunnel from Section No. 2 to to Section No. 5	3,000 lin. ft.	8.00	24,000.00
7	Concrete lining in tunnel	500 c. y.	18.00	9,000.00
8	Additional excavation tunnel	200 c. y.	4.00	800.00
10	Excavation in overflow shafts	250 c. y.	5.00	1,250.00
13	Excavation in open cut	500 c. y.	2.25	1,125.00
16	Extra Cement	50 bbls.	4.40	220.00
17	Reinforcing steel	5,000 lbs.	.07	350.00
	Total, Contract 113-E			$779,745.00

The combination of the lowest bid on Proposition C with the lowest on Proposition E appeared to be most advantageous to the City. Two contracts were therefore awarded on September 20, 1926, as follows:

Contract 113-C. to A. Guthrie and Company of Portland, Oregon, for the complete construction of the tunnel in the Rock River and Oakdale Sections. The estimated contract price was $1,257,952.50. The contract was signed on September 29, 1926. The contractor took charge of the work at Rock River shaft and Oakdale Portal on November 1, 1926.

Contract 113-E, to T. E. Connolly and J. M. DeLuca of San Francisco for the excavation and timbering where necessary of tunnel, and lining short sections where ordered, in the Brown Section. The estimated price was $779,745.00. The contract was signed on September 28, 1926. The contractors took charge of the work at Brown Adit on October 1, 1926.

Details as to progress under the two contracts are given later in this report.

All camps were completed and fully equipped, and aqueduct construction work commenced at all camps, all by the City's forces, before the contractors took up their work. The Brown Adit, Rock River and Oakdale Portal camps and their equipment were turned over to the contractors, without charge except for small tools, boarding house utensils and consumable supplies. The equipment, as at the camps at the other Foothill

Division working points had been nearly all transferred from the Mountain Division tunnel work. All secondhand equipment was thoroughly overhauled and put in good working order at the Hetch Hetchy Junction shops before being installed at the new camps. On completing contract work all free equipment must be returned by the contractors in as good condition as when furnished to them, less reasonable wear and tear due to use on the work. The cost of maintenance and repairs is borne by the contractors.

Free transportation for men and freight between Hetch Hetchy Junction (the distribution center for the division) and the camps is furnished to the contractors, with restrictions to prevent abuse of the free-haul privilege and with provision for charging at regularly established rates for special service. The furnishing of camps and equipment and transportation without charge was provided for in the specifications and entails no loss to the City, as the saving to the contractors was taken into consideration by them in fixing their bid prices.

Electric power from Moccasin is furnished to the contractors at a rate of one cent per kilowatt-hour delivered at each camp sub-station, and water from Priest Reservoir is furnished from the Foothill Division water supply system for twenty cents per 100 cubic feet. These services were not furnished free as the meter rate is the best check on waste.

Shop work is done for the contractors in the City's shops, at rates based on cost of service.

Moccasin Reregulating Reservoir:

The flow of water discharged from the Moccasin Power House varies greatly throughout the day in proportion to the demand for electrical energy, and since the flow in the aqueduct below for water supply purposes must be at an approximately uniform rate it is necessary to construct a tailrace reservoir to regulate the differences in flow, reversing the function of the forebay reservoir.

The reservoir will have a capacity of about 500 acre feet. It will occupy a basin formed by cutting off a section of the existing channel of Moccasin Creek between two dams, one upstream from the tailrace, the other downstream from the tunnel intake. The downstream dam, the sixth to be constructed on this project, will be approximately 800 feet long and 60 feet high, of the rolled earth fill type with rock fill toes, having a reinforced concrete core wall extending the full length and height of the dam. The spillway elevation is 920 feet.

A reinforced concrete conduit extending throughout the length of the reservoir will bypass the flow of Moccasin Creek to prevent pollution of the water supply.

The City's field forces started work at this point in December, 1926. To take care of the flow from the Moccasin Power House during the construction of the concrete conduit through the proposed downstream dam, a rock filled crib dam has been constructed and the flow diverted through a wooden box flume 17 feet wide by 5 feet 6 inches deep and 750 feet long.

The cofferdam and flume were completed May 22, 1927, when the creek was diverted from its normal course. The original channel was stripped to bedrock to provide suitable foundation for the concrete conduit to be built through the dam.

HETCH HETCHY AQUEDUCT—DIVERSION FLUME AT MOCCASIN RE-REGULATING RESERVOIR

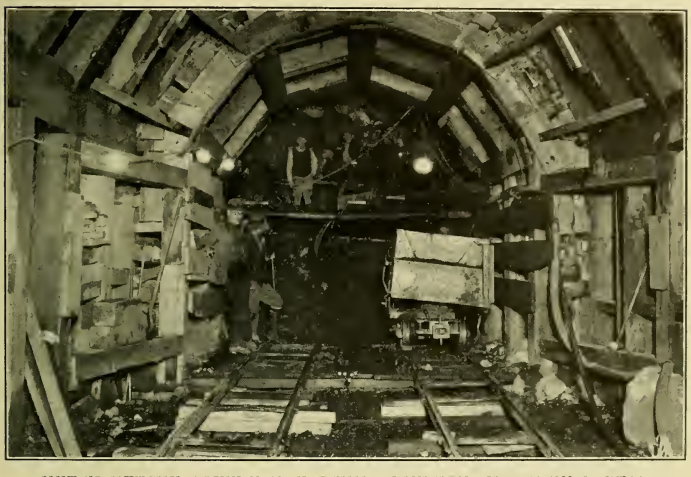
Flume diverting flow of Moccasin Creek during construction of downstream dam of Moccasin Reservoir

Actual field work on the downstream dam for the fiscal year included a partial clearing of the site and the digging of test pits along the axis of the proposed dam.

Tunnel Construction Operations:

Moccasin Portal: Construction of the camp at this point was commenced May 28, 1926. The camp was available for occupancy August 3, and all buildings were completed by the end of September. This camp accommodates the crews on tunnel construction and on the Moccasin Reregulating Reservoir dam and other structures. It consists of 20 bunkhouses, a combined dining room and kitchen, bath houses, office, warehouses and a shop building. Plant and equipment for excavating one heading were installed during construction of the camp.

Excavation of the portal cut was started on August 2, 1926. The usual practice is to make the bottom grade of the portal cut practically level at the elevation of the tunnel invert. At this point, however, it was necessary to use a different layout, since the invert grade elevation of 881 feet at the portal is so low that there would be danger of flooding the tunnel work through a level cut during the high water periods of Moc-



HETCH HETCHY AQUEDUCT, FOOTHILL DIVISION—MOCCASIN PORTAL TUNNEL HEADING

Interior of timbered tunnel. Heavy ground necessitated use of wall plate method of timbering and wider excavation for thicker concrete lining to this point where tunnel section is reduced

casin Creek. Therefore, an inclined open cut commencing at a point about ten feet higher, well back from the creek, was excavated on a 14% grade descending to the portal and an electric motor-driven hoist installed to haul the muck trains up the incline from the tunnel portal to the upper level and lower them back. The motor has remote control equipment and is started, for either hoisting or lowering, by the motorman of the muck train locomotive, and stopped automatically by a limit switch.

The portal was faced on September 18, 1926. A special heavy reinforced concrete lined tunnel section 15 feet 2½ inches wide and 14 feet 11½ inches high inside of timbers was designed to support the heavy ground and external water pressure near the portal. This was driven

450 feet from the portal, until the full face was well into solid rock. Due to the nature of the formation, which was soft slate with boulders and clay saturated with water, the ground was hard to hold and the wall plate method of driving was used. Wall plates 10 inches by 10 inches, supported on posts at 2 foot centers and carrying 5-segment arch rings built continuous, were used. The finished waterway in this section will be circular, 10 feet 3 inches in diameter, and the concrete will have a minimum thickness of 18 inches. At 450 feet from the portal, the face was well into firm Mariposa slate, which though badly broken up, warranted a change to the standard lined tunnel section No. 2, with timbering.

Considerable water was met in this heading, a maximum flow of 610 gallons per minute in the month of April, 1927, and an average of 275 gallons per minute for the 9½ months period being handled by the pumps.

Progress in this heading was necessarily slow due to heavy ground which required timbering. Of the 2194 feet driven to July 1, 1927, 1564 feet were driven at an average rate of 184 feet per month for the first 8½ months of work, while in June 1927 a progress of 630 feet was made, better ground, diorite and slate mixed, schist and also Mariposa slate, having been encountered. Timbering was required in 1306 feet of the 2194 feet driven, or practically 60 per cent.

All work at this camp, including the building of the rock crushing plant described earlier in this report, has been done by City forces.

Brown Adit: Work was carried on at this camp by City forces until October 1, 1926, when T. E. Connolly and J. M. DeLuca took charge under Contract No. 113-E. Prior to October 1 the City forces completed the camp construction, plant installation, the construction of the tramway and cableway previously described, and had, with one shift per day, excavated 852 feet of tunnel east from the adit and 854 feet west.

Contract No. 133-E calls for the driving of approximately 16,800 feet of tunnel, working east and west from Brown Adit. The contractors established their crews on a two shift basis in both headings on October 7th and have maintained good progress in advancing in both directions.

No unusual difficulties were encountered during the year. The formation is amphibolite schist which at some points requires timber for support. On February 1 the tunnel section in the east heading was changed from the standard lined section No. 2, with an area of excavation of 112.1 square feet, to the standard unlined section No. 5, with an area of 166.5 square feet, the decision being made to leave the tunnel permanently unlined in the hard sound rock and compensate for the increased frictional resistance to flow due to the rough rock surfaces by increasing the area of the waterway. No appreciable amount of water has been en-

countered in either heading. A small crew has been engaged at odd times by the contractors in excavating the open cut at the Red Mountain, East Portal, where the tunnel being driven westerly from Brown Adit will hole through.

Pedro Adit: The camp and plant installation at this working point was completed prior to June 30, 1926, as described on page 57 of the report for 1925-1926. All work at this point has been done by City forces, and an excellent rate of progress has been maintained during the year. The east heading was advanced 613 feet and holed through at Red Mountain West Portal on September 28, 1926. The open cut approach to this portal was completed on October 18. The formation encountered was decomposed granite and huge granite boulders, requiring timbering throughout. All but 37 feet of the 1154 feet of tunnel driven between Pedro Adit and Red Mountain West Portal required timbering. Standard tunnel section No. 2, to be lined with concrete, was driven in this heading.

The west heading was steadily advanced at a very nearly uniform monthly rate, a progress of 6549 feet being made during the year in a formation of diorite and slate, the slate contact being met on May 28. This total progress represents an average monthly advance of 546 feet. Standard tunnel section No. 2, was driven in this heading also.

Water has not hampered the work in either of the two headings. No water was encountered in the east heading and very little in the west, the maximum running to 40 gallons per minute flow in March, 1927.

A crew working out of this camp handled the construction of the west anchors, head tower and miscellaneous structures, the erection of the hoist, and other erection work for the Red Mountain Bar cableway above described.

Hetch Hetchy Junction: Very good progress was maintained in the headings east and west of Hetch Hetchy Junction Shaft. During the fiscal year 5840 feet in the east heading, at an average rate of 487 feet per month, and 5528 feet in the west heading, averaging 461 feet per month, was driven. During March, 1927, the east heading was advanced 781 feet, which betters by 5 feet the previous record run of 776 feet made in August, 1921, in the Priest heading of the Mountain Division tunnels, and establishes a new record for one month's progress in tunnel excavation for the Hetch Hetchy System.

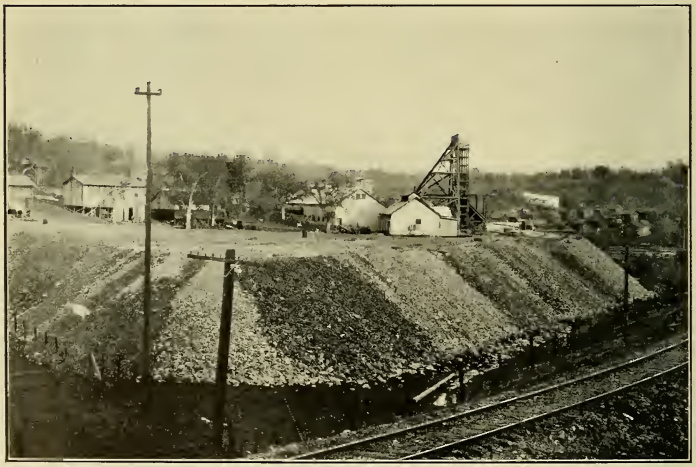
The formation penetrated in the east heading is slate and sandstone throughout and has required timbering in 2191 feet of tunnel. No appreciable amount of water has been encountered in this heading.

On August 12, 1926, the contact between slate and firm sound schist was met in the west heading. At this point a station for the repairs to mucking machines, locomotives, cars, etc., was excavated. The formation

in the schist was fairly uniform, with occasional soft talc seams that required timber. A total of 115 feet of timbered section was placed in this heading. On June 8, 1927, a flow of water estimated at 250 gallons per minute under a pressure head of 80 lbs. was tapped and all driving operations in this heading were suspended. Holes were drilled in the face and arch of the tunnel and cement grout was forced into the seams in the rock through these drill holes under 450 lbs. pressure. This grouting successfully sealed off the inflow of water and permitted tunnel driving to be resumed.

All work at this point has been done by City forces. Prior to November 24 tunnel work was carried on by three shifts alternating in the two headings but on that date the crew was increased to three shifts in each heading.

Standard tunnel section No. 2 has been driven in both headings. Some portions of this length of tunnel located in favorable ground are later to be enlarged to standard section No. 5.



HETCH HETCHY AQUEDUCT, FOOTHILL DIVISION—HETCH HETCHY JUNCTION SHAFT

Headworks, plant, camp buildings and dump. Shaft, 180 feet deep, gives access to the aqueduct tunnel

Rock River: Work at this point was carried on by City forces until November 1, 1926, when A. Guthrie and Company commenced work under Contract No. 113-C. From July 1, 1926 to that date the City's forces had completed the excavation of 1669 feet of tunnel in the east heading and 1282 feet in the west heading. An enlarged section or station was excavated adjacent to the tunnel section proper in the east heading to provide underground shop space for maintenance and repair work on mucking machines and other tunnel equipment. This station was completed on August 6th.

The scope of Contract No. 113-C has already been described in this report. The contractor took up the driving of the tunnel without interruption to the work and has maintained a satisfactory rate of tunnel progress, advancing the east heading 3876 feet in eight months at an average rate of 487 feet per month and the west heading 3353 feet at an average rate of 419 feet per month.

Several cottages to accommodate the contractor's field superintendent and office force and additional warehouse space were built by the contractor at this camp during the month of November.

The geological formation encountered in both headings was a uniform hard schist that required but very little timbering. The total length of timbered tunnel for both headings up to June 30, 1927, was 380 feet. Prior to May 8, standard tunnel section No. 2 (for concrete lining) was driven in the east heading. A change was then made to unlined section No. 5. Surface rock outcrops indicate that this heading will continue in hard schist to the point of holing through with the tunnel from Hetch Hetchy Junction shaft west. Section No. 2 has been used throughout the west heading. Some portions of the tunnel in favorable ground, already driven to section No. 2, will later be enlarged to section No. 5.

On March 10, 1927, in the west heading, in a formation of blocky schist, full of seams and with a horizontal slab in the roof, a flow of water measuring initially 600 gallons per minute was tapped in drilling the face. This flow soon flooded the heading and prevented work at the face for several days, while additional pumps and pipe lines were being installed to handle the water. On March 17, grouting to cut off the water was commenced through 14 holes varying in depth from 5 to 18 feet drilled in the face and arch. At that time the flow was about 200 gallons per minute.

Prior to grouting each hole, sodium silicate solution and aluminum sulphate solution were injected into the hole. Neat cement grout was then forced in under a pressure of 95 lbs., using a Canniff machine. All holes were grouted to refusal and the face was absolutely dry on completion of the grouting.

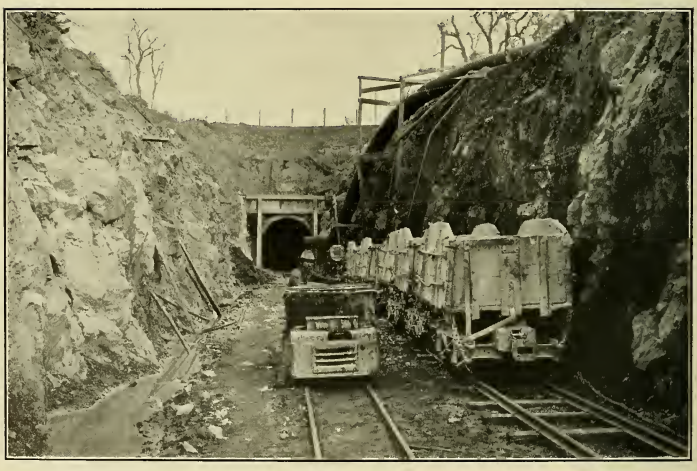
Grouting was again necessary after driving the tunnel 17 feet farther, to cut off a flow of about 250 gallons per minute. This was finished

March 23. The zone of broken ground in which these flows occurred is about 142 feet through. On conclusion of the tunneling through this section it showed a flow of not over 5 gallons per minute.

Oakdale Portal: This point is the west end of the Foothill Division. Early in the fiscal year the City forces constructed shops and plant buildings and installed equipment for driving the tunnel eastward. The excavation of the open cut approach to the portal, involving the moving of 5527 cubic yards of material, also handled by the City forces, was started July 31 and completed October 17.

On November 1, A. Guthrie and Co., under Contract No. 113-C, took charge of the work at this point. The contractor's forces took up the work without delay and faced up the tunnel portal, going under ground on November 2. No unusual difficulties were encountered in this heading and a progress of 4283 feet at an average rate of 535 feet per month was made.

The ground penetrated in this heading is a firm schist, with occasional talc seams requiring timber for support. Of the 4283 feet driven, 475 feet or 11.1% was timbered. Standard section No. 2 was driven throughout.



HETCH HETCHY AQUEDUCT, FOOTHILL DIVISION—OAKDALE PORTAL

Western terminus of Foothill Division tunnels, where pipe line across San Joaquin Valley will begin

Summary of Tunnel Progress for the Year: The following table shows the progress in excavation of tunnels for the fiscal year 1926-1927 and the total progress to June 30, 1927. For comparison, the distances between working points, representing the total length of tunnel driven and to be driven, are also shown:

HETCH HETCHY AQUEDUCT, FOOTHILL DIVISION

Progress of Tunnel Excavation

Working Point	Distance Driven during 1926-27 linear feet		Total Driven to June 30, '27 linear feet		Distance Between Working Points
	East	West	East	West	
Moccasin Portal: City forces		2194		2194	
					21110
Brown Adit: City forces	852	854	879	903	
Contract work	4018	4201	4018	4201	
Total	4870	5055	4897	5104	
					6769
Red Mountain East Portal (Not a working point)					
Red Mountain West Portal (Not a working point)					
					1179
Pedro Adit: City forces	613	6549	1179*	8245*	
					23477
Hetch Hetchy Junction Shaft: City forces	5840	5528	6017	5795	
					15283
Rock River Shaft: City forces	1669	1282	1711	1334	
Contract Work	3876	3353	3876	3353	
Total	5545	4635	5587	4687	
					15859
Oakdale Portal: Contract work	4283		4283		
Totals, City forces		25,381		28,216	
Totals, Contract Work		19,731		19,731	
Totals, in feet, City and Contract		45,112		47,947	83,677
Totals in miles		8.54		9.08	15.85

*Figure for east includes 25 ft. actually in open cut east of center line of adit. Figure for west includes 16 ft. in open cut west of center line of adit. The adit itself is really an open cut approach.

The following table shows the length of tunnel timbered and percentage timbered of total length of tunnel excavated to June 30, 1927:

HETCH HETCHY AQUEDUCT, FOOTHILL DIVISION

Length of Tunnel Timbered

(from commencement of construction)

Percentages shown in the last two columns below are based on total progress to June 30, 1927, as shown in table above.

	Timbered Tunnel Linear feet		Per Cent Timbered	
	East	West	East	West
Moccasin Portal		1306		59.5
Brown Adit	252	283	5.2	5.5
Pedro Adit	1117	837	96.8	10.1
Hetch Hetchy Junction Shaft	2191	115	36.4	2.0
Rock River Shaft	20	360	0.4	7.7
Oakdale Portal	475		11.1	
Totals	6956 feet (1.32 miles)		14.5%	

Mechanical Equipment for Tunnel Construction:

The tunnel construction equipment used in the Foothill Division is standardized according to the requirements of the various working points and, so far as economical and practical, individual units have been standardized, so that like parts are interchangeable. The greater part of the equipment was salvaged from the tunnel work in the Mountain Division.

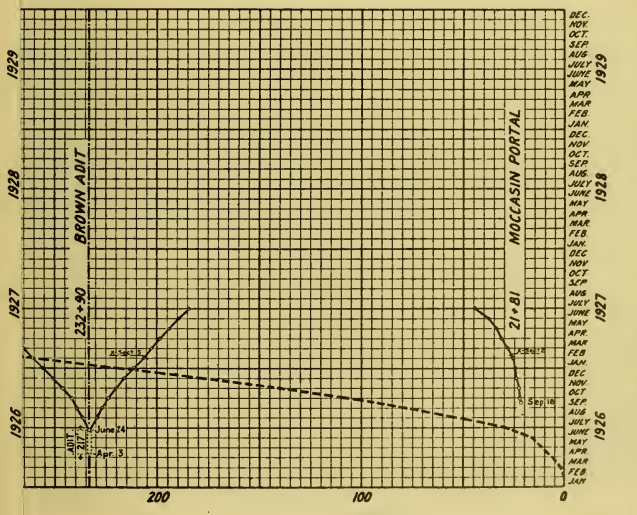
Air Compressor Units: The standard unit adopted for supplying compressed air is a horizontal cross compound air compressor with intercooler between cylinders and with fly-wheel pulley driven by short-belt drive from a 100 H.P. motor. The displacement capacity of the compressor is about 670 cubic feet of free air, with a net of about 570 cubic feet a minute at 100 pounds gage pressue.

This standard unit has been found nearly adequate for one face or heading of the tunnel under all ordinary operating conditions.

Each compressor is connected to one air receiver, 48″ diameter and 12 feet high, with a capacity of 150 cubic feet or practically twice the capacity per minute of the compressor at the delivered pressure. The pipe line to the face of the tunnel is 4″ diameter and a smaller auxiliary receiver is generally used, cut into the pipe near the face, when the distance from compressor to face is more than 2500 feet.

Cooling Towers: In the Foothill Division a cooling tower was installed at each camp to conserve the cooling water required for the compressors. The water used at all the camps except Moccasin Portal is brought from Priest Reservoir through a pipe system aggregating 25 miles in length. In designing the supply line, the use of cooling towers was prescribed in order to conserve water and thus hold the pipe size down to a minimum.

DIVISION T

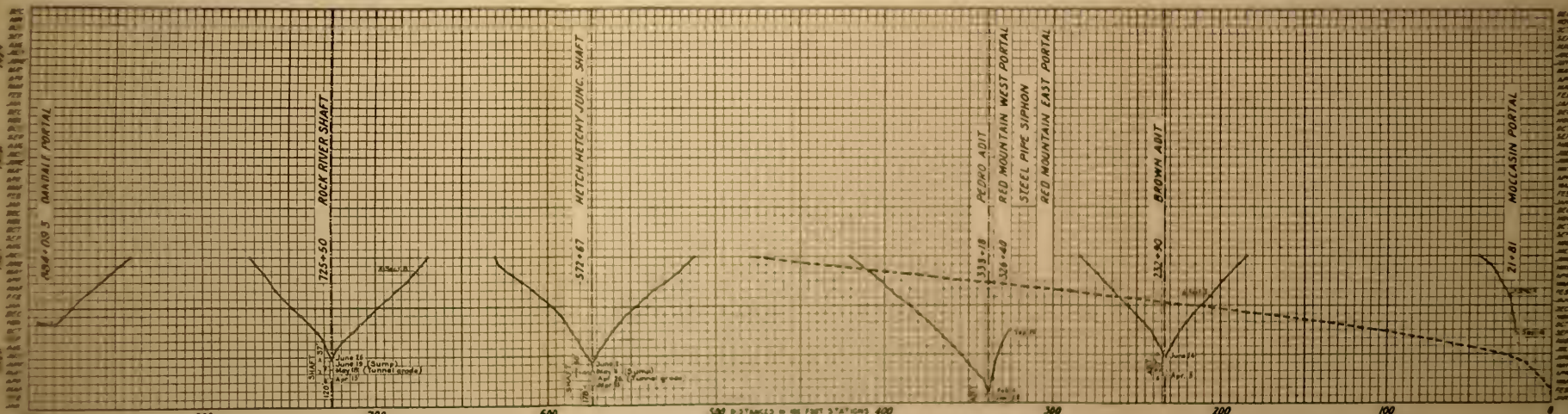


M. M. O'SHAUGHNESSY
CITY ENGINEER

R-212

HETCH HETCHY AQUEDUCT - FOOTHILL DIVISION

TUNNEL PROGRESS CHART



R-212

Ventilation for each heading is supplied by a positive blower with a nominal capacity of 4500 cubic feet of air per minute under 20 ounces pressure and belt-driven by a 25 H.P. motor. Blower and motor comprises a blower unit. Ventilating pipe is 24" diameter in about 19-foot lengths, of 1/16" sheet metal, riveted and dipped in asphalt. Ends of pipe sections are butted together and joined by bolted cinch bands, which also are dipped. Blowers are fitted with four-gate systems to permit either exhausting smoke and gases from the headings or blowing in fresh air.

Mucking Machines are used in all faces. The Myers-Whaley type having electric motor drive, with swinging shovel and conveyor belt, is found to give excellent results.

Haulage: Four and five ton storage battery locomotives are used in each heading to haul muck trains from the faces of the tunnel to shafts or directly to dumps at portals and adits. Cars are of the side dump type, of 50 and 80 cubic feet capacity. The track gauge is 24 inches.

Equipment for Single Heading Camp: A single heading camp is one from which tunnel is driven in one direction only from a portal. Such camps are equipped with:

2 air compressor units
1 blower unit
1 drill steel sharpening machine
1 drill steel heating furnace
2 mucking machines
2 or 3 storage battery locomotives
2 extra batteries for locomotives
12 to 18 rock cars
Blacksmith and repair shops
Cooling tower
Outdoor step-down substation, 22000 - 440 volts.

Equipment for Double Heading Camp: A double heading camp is one from which two headings are driven in opposite directions from an adit. The equipment comprises:

3 air compressor units
2 blower units
1 drill steel sharpening machine
1 drill steel heating furnace
3 mucking machines
3, 4 or 5 storage battery locomotives
0 to 3 extra batteries for locomotives
20 to 36 rock cars
Blacksmith and repair shops
Cooling tower
Outdoor step-down substation, 22000 - 440 volts.

Two locomotives would be sufficient for underground haulage equipment in a single heading camp and three for a double heading camp, one in each case being a spare. However, additional locomotives were on hand and were therefore distributed to the work. When needed for work in the Coast Range they will be transferred.

Equipment for Shaft Camp: A shaft camp has the same equipment as the double heading camp, and in addition:

1 double-drum geared motor-driven hoist, capacity about 6,000 pounds load hoisted at a speed of from 400 to 600 feet a minute.

The rock is hoisted in a self-dumping skip of 32 cubic feet capacity loaded from a rock pocket at the bottom of the shaft and dumping into a rock bin at the surface.

There are also a bailing bucket, one or two sinking pumps, both air and electric motor-driven, and station pumps at the bottom of the shafts. Station pumps are electric motor-driven high-duty centrifugal pumps of large capacity.

Outside Haulage Equipment: Besides the equipment listed above. three camps (Moccasin Portal, Hetch Hetchy Junction and Rock River) are each provided with one of two gasoline locomotives and the necessary cars for outside work on the dumps.

Equipment for Lining Tunnels: At each of the three stations from which tunnel lining operations are to be carried on (Moccasin Portal. matic concrete placing guns fed direct from a mixer, will be used in the lining of tunnels. The equipment previously used for lining tunnels in the Mountain Division, has been overhauled in preparation for use in this division. Steel forms for tunnel section No. 1 are being remodeled for tunnel section No. 2 for the Foothill Division lining work.

At Moccasin Portal rock from the tunnel excavation is to be crushed for use as aggregates for the tunnel lining. The crusher plant, bins, etc., have been installed. For the two shafts, aggregates will be purchased from commercial sand and gravel plants and hauled to the shafts.

Spare Units: At each camp, whether single or double heading, a mucking machine and a storage battery locomotive are provided for each heading and at least one additional unit of each as a spare available for use in either heading.

Coast Range Division

During the fiscal year the definite location of the aqueduct in the Coast Range Division made by the City Engineer was approved by the Board of Supervisors and funds were made available to proceed with the work. Shaft sinking was begun at Arroyo Mocho, one of five shaft lo-

cations on the tunnel line. As the year closed, construction of roads, camps, camp water supply systems, telephone lines and the electric power system for construction purposes was well under way. Tunnel alignment surveys were being made, and also surveys for camp water supply pipe lines, telephone and transmission lines and roads. All construction to date has been by day labor.

Actual construction was only started in the month of April, 1927, a great deal of time having been lost due to delay on the part of the Board of Supervisors in approving the budget of expenditures submitted by the City Engineer for preliminary work, shaft construction and commencement of tunnel construction in this division. Following the completion of core borings along and near the aqueduct tunnel line and detailed studies of the geology of the locality, a report on the final location of the aqueduct as adopted by the City Engineer, with a budget of proposed expenditures for preliminary construction work, was submitted to the Board of Supervisors on October 4, 1926. The report referred to, with a general map of the tunnel location, appears in the annual report for 1925-1926, pages 59, 60 and 61. The budget was approved, after a delay of five months, on March 5, 1927, by Resolution No. 26845 (New Series) of the Board of Supervisors, making available $1,502,554 from the 1925 Water Construction Fund for work outlined as follows:

Hetch Hetchy Aqueduct—Coast Range Division
General Description of Work Contemplated Under the City Engineer's Budget of Proposed Expenditures
Dated October 4, 1926

1. **Rights of Way:** Purchase of the sub-surface easement for the construction of the entire series of tunnels in the Coast Range from Tesla Portal to Irvington gatehouse, together with such surface rights as are necessary for the construction of roads, telephone lines, local power transmission lines, camp water supply lines, and also land for camp and dump purposes.

2. **Preliminary Construction Work:** Includes construction of roads, telephone lines, local power transmission lines, camps, purchase of new equipment necessary to supplement the equipment already available from the Mountain Division, installation of plant and equipment, camp water supply systems, and other incidental construction necessary previous to the commencement of actual shaft and tunnel construction at the various working points.

3. **Shaft Construction:** Includes construction of five shafts at such intervals along the line of the aqueduct tunnel as will divide the work into sections of about three to five miles in length between working points, such units being considered well suited to the requirements of our work from experience in the Mountain Division. The shafts will be of the same type as used in the Mountain and Foothill Divisions of the aqueduct, each shaft having three compartments—two for hoisting and one for pipes and manway.

4. **Tunnel Construction:** Includes commencement of tunnel construction at Tesla Portal, which is the east end of the Coast Range Division. The tunnel will be of approximately the same dimensions as the tunnels now under construction in the Foothill Division and will be lined throughout with concrete.

General: The above described work at five shafts and one portal location comprises the work which must necessarily be started in the very near future in order that the Coast Range Division of the Hetch Hetchy Aqueduct shall be completed and ready for use within not more than five years' time. Tunnel work will also be necessary from three additional working points located respectively at the east and west sides of the valley of Alameda Creek and at Irvington Portal. These three points are not mentioned in any of the items of the budget hereinabove set forth. Should it be found that the funds covered under any of the items are in excess of the actual requirements, the excess will be devoted to commencement of tunnel construction at the shafts and to the establishment of camps at the three portals last mentioned and commencement of tunnel construction at those portals, to the extent of the funds available.

Study of Alternative Pipe Line Route with Pumping:

On considering the budget of October 4, 1926, the Public Utilities Committee of the Board of Supervisors on October 27 requested an immediate report from the City Engineer as to what time and money would be saved by the City if a pipe line from the west side of the San Joaquin Valley to Irvington via Altamont Pass were substituted for the proposed direct grade tunnel through the Coast Range. In compliance with this request the City Engineer on November 3, submitted a report showing the relative economy and desirability of the tunnel plan.

Economic comparison between tunnel and pipe line was of course made before the tunnel plan was definitely incorporated into Mr. Freeman's layout of the Hetch Hetchy Aqueduct in 1912. All previous plans for the aqueduct contemplated the use of a pipe line over the hills with short tunnels to reduce summit elevations. Pumping would be necessary as a part of those plans; gravity delivery would be physically feasible but economically impracticable.

Comparing the all-tunnel plan with the pipe plan involving pumping, the report showed that the initial cost of the pipe system with a capacity of 60,000,000 gallons daily would be about half the cost of a tunnel of 250,000,000 gallons daily capacity between the same two points. However, when the capitalized costs of pumping and fixed charges are added to the initial investment the resultant cost is about the same for either system, namely approximately $16,000,000. The City would be virtually tying up as much of its capital for the 60,000,000 gallons daily pipe-and-pumping system as for the 250,000,000 gallons daily tunnel, besides which the pipe line for 60,000,000 gallons daily would have to be paralleled in 12 years with additional units with corresponding increases in pumping capacity from time to time to provide additional water to keep pace with the rapid growth of the City and the Peninsula district.

All engineering and economic factors strongly favor the initial tunnel construction. The time saving possible by adopting the pipe system would be about one year, which is of no great consequence as the tunnel construction can still be completed in time to furnish additional water when the demand overtakes the capacity of the Spring Valley sources.

In order that the Public Utilities Committee might have the views of an outside engineering expert as to the soundness of the bases used and conclusions reached in the report of November 3, 1926, the City Engineer requested Dr. W. F. Durand, former head of the Engineering Department of Stanford University, to make an independent review to determine the relative merits of the gravity and pumping schemes and report his conclusions.

Dr. Durand reported in detail on the comparison of the cost, time required and general advisability of the two systems. His results and conclusions strongly favored the gravity tunnel plan and substantiated the recommendations previously brought out in the City Engineer's report.

Capacity and General Design of Aqueduct:

The design of the Hetch Hetchy System is based upon an ultimate supply of 400,000,000 gallons daily to the San Francisco metropolitan area. The 10 ft. 3 in. diameter tunnels east of the San Joaquin Valley are designed to take that entire quantity. In the Coast Range, however, a flatter grade line is necessary and a tunnel about 13 ft. in diameter would be required to give the same flow, or two 10 ft. 3 in. tunnels might be used. On comparing the cost of a 13 ft. tunnel with that of a 10 ft. 3 in. tunnel plus the discounted cost of a second paralled one to be constructed not less than 25 years in the future, it was seen that the latter is the more economical plan. The first tunnel, though intended to carry 200,000,000 gallons daily after being paralleled, can be made to carry 250,000,000 gallons daily, and it does not appear probable that the demand for water from the aqueduct will reach that figure within 25 years after completion of the first tunnel.

The adopted scheme, therefore, is to construct at this time a tunnel 10 ft. 3 in. in diameter, 95 feet distant on northerly side of shafts, and to parallel it with a second similar tunnel on the southerly side in future when necessary to satisfy the ever increasing demand for water.

Steel pipe siphon construction will be used to connect across Alameda Creek Valley between the two sections of the tunnel.

The total fall in the tunnel grade will be about 83 feet between Tesla Portal (elevation 399 feet) and Irvington Portal (elevation 316 feet), a total distance of about 29.2 miles. The fall in different sections is 0.5 ft. and 0.7 ft. per 1000 ft. length, or 2.64 ft. and 3.70 ft. per mile. A slightly greater rate is assigned to the Alameda Creek siphon.

Surveys:

The preliminary survey of 1916, run through the Coast Range as a part of the general survey of the entire aqueduct line from Oakdale to San Francisco, has served as the base line for the final location, parts of it being actually adopted without alteration as the final location.

Property ties and maps made at the time this survey was run have been extensively used in the descriptions of lands and rights of way purchased.

Two men under the direct supervision of the San Francisco office were employed during the fall of 1926 in making spring and well measurements and miscellaneous surveys in connection with the aqueduct location studies. In November, 1926, a survey crew of 7 men started work on location of roads, water pipe lines and camp sites and on the final surveys of the adopted tunnel line.

As the year closed the survey party, increased in numbers, has been particularly busy in securing data required by the City office for descriptions of lands and rights of way to be acquired.

Right of Way Acquisitions:

As soon as funds for land purchases were made available and property ties surveyed, definite descriptions of the lands and rights of way required for the tunnel and auxiliary construction features were prepared in the City Engineer's office and the purchase of the necessary rights of way and lands was commenced. A subsurface easement is taken for two tunnels, with provision in all documents that rights purchased shall be permanent and apply equally to the construction of the second tunnel to be built in this right of way. Surface easements were acquired for the telephone and electric power lines and water supply lines. Road rights of way are taken in fee or in easement. Camp and dump sites are generally being acquired in fee.

The land in this region is privately owned and is used almost throughout the area traversed for grazing cattle and sheep. In general, it is held in comparatively large holdings, there being no towns or other subdivisions in the close vicinity of the aqueduct. Right of way purchases will require dealing with about 40 property owners.

At the close of the fiscal year the Mocho Shaft camp and dump site had been purchased in fee and the necessary easements in that immediate vicinity for the tunnel and auxiliary construction features secured, permitting construction work to be started at that point. The Seco Substation site was purchased and negotiations were in progress for the purchase of power transmission line rights of way to extend from the substation to the tunnel line.

Roads:

A considerable amount of road work is necessary to give access to the various working points in the Coast Range Division. Although the shaft and portal camps are located close to existing roads, most of these roads require extensive repair work and in some instances reconstruction to accommodate heavy truck traffic. Roads ranging from a few hundred feet to over a mile in length, connecting the camps with existing roads, are to be built at all points.

On the county road from Livermore to Corral Hollow, locally known as the Tesla road, a joint arrangement was made with the Supervisors of Alameda County whereby the City of San Francisco will bear one-half of the expense of putting this road in good condition and the County the

other half. In April, 1927, the City's forces started shaping up this road with a heavy grader and a 60 horsepower tractor. Drainage ditches and culverts were also constructed. A gravel surface will be placed by the County as its share of this work. This road will be the principal route for travel to Mitchell Shaft camp, Thomas Shaft camp and Seco Substation.

The City's private branch road extending from the county road known as the Mines Road to the Mocho Shaft was built during May and June, 1927. This road is 7/8 mile long and its construction involved the excavation by a gas-air shovel of approximately 30,000 cubic yards of earth and rock. The Mines Road runs on a southeasterly course from Livermore and up the east side of the Arroyo Mocho Canyon. The City's new road joins this county road about 8½ miles from Livermore.

A camp is being established at the junction of the Tesla Road in Corral Hollow and an existing road that leads to the Mitchell Shaft location. This is in preparation for the work of reconstructing the latter road. The reconstruction will involve widening and partial realignment of about 1½ miles of road.

Seco Substation, Transmission Lines and Telephone Lines for Aqueduct Construction:

Electric power to be used in the Coast Range Division will be taken from the City's Moccasin-Newark transmission line at Seco Substation. At this station a 6,000 K. V. A. transformer bank will step down the voltage from 102,500 to 23,000 for distribution over two feeders.

A 2.8 acre tract of land adjoining the Tesla Road was purchased in fee as a site for the Seco Substation. This site was graded to accommodate the buildings and other structures to be built and a semi-permanent cottage is being built. This cottage will be used as a cook house during the construction of the station, and later as living quarters for an attendant.

The transmission line will be a three-phase 22 kv. line of No. 2 and No. 4 copper wire and will extend in two directions from the substation. The east line will follow a general southeasertly course to Mitchell Shaft and then parallel the tunnel line easterly to Thomas Shaft and Tesla Portal. The west line will run from Seco Substation southwesterly to Mocho Shaft and then westerly along the tunnel line to Valle Shaft, Indian Creek Shaft, the two Alameda Creek Portals and Irvington Portal. During May, 1927, the telephone and transmission line right of way between Seco Substation and Mocho Camp was cleared and pole holes were dug, the right of way between Mocho Camp and Mitchell Camp was being cleared and pole holes for a telephone line between Livermore and Seco Substation were dug. Purchase of rights of way and the building of telephone and transmission lines to Mocho Camp were given preference over other localities in order to establish communication and deliver power to this camp at the earliest possible time.

Contracts were let in May and June, 1927, for furnishing and delivering transformers, switch gear, lightning arresters and disconnecting switches for Seco Substation, and copper wire, insulators and pins for the transmission lines. Cedar poles for transmission and telephone lines were purchased in the open market.

The cost of this power system for construction purposes is estimated at $285,000, divided as follows: Seco Substation, $155,000; transmission lines to all camps, and substations at all camps, $130,000.

The telephone system in the Coast Range Division will include connections between the headquarters office at Livermore, Seco Substation and the tunnel construction camps. The lines will be strung on wooden poles and will generally parallel the power transmission lines between working points.

Camp Water Supplies:

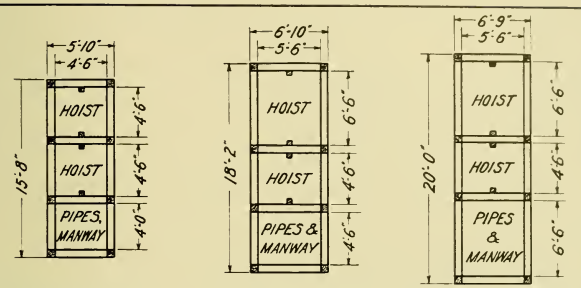
Water for construction camp purposes in the Coast Range Division will be taken from streams, springs and wells in the vicinity of the aqueduct lines. These sources have been studied throughout the fiscal year, and tests have been made to determine the sufficiency and suitability of the water available.

The water supply for Thomas Shaft and Mitchell Shaft Camps will be drawn from wells in the bed of Corral Hollow Creek, on City property above Castle Rock, and pumped through three-inch pipe lines about 3 miles and 6 miles long respectively. The supply at Mitchell Camp will be supplemented by using water from Laurel Spring, ¾ miles south of the camp. Mocho Camp will be supplied partly from a spring near the camp and partly from the flow of Arroyo Mocho, and Valle Camp from Leal Spring through 3¾ miles of pipe. The camps at Alameda Creek will be supplied from the flow of water regularly released from the Calaveras Reservoir of the Spring Valley Water Company. Sources of water for the other camps in this division are being investigated.

Shaft Construction:

The Coast Range Division will be constructed from four portals and five shafts, giving fourteen working faces. The maximum distance between working points is 5.2 miles, from Mocho Shaft to Valle Shaft. Experience on the Mountain Division tunnels has shown that such a long distance is not inconsistent with economical construction.

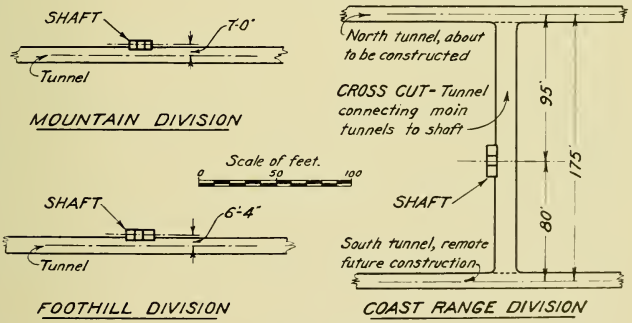
Shafts will be similar to those of the Foothill Division, with three compartments, two for hoisting and one for pipes and manway. The overall dimensions (in plan) to the outside line of the timber sets will be: length, 20 ft.; width, 6 ft. 9 in. The shaft at each location will connect at tunnel grade with a cross drift between the present and future tunnel lines, as shown on drawing A-336 herewith reproduced. The arrangement permits the use of the shaft for construction of the second tunnel without interfering with the operation of the first tunnel. Permanent concrete lining will be constructed in all shafts.



MOUNTAIN DIV. FOOTHILL DIV. COAST RANGE DIV.

GENERAL DIMENSIONS OF SHAFTS

Timber sets (horizontal frames) are spaced 5 ft. center to center.
Logging is used outside of sets to the extent necessary.



POSITIONS OF SHAFTS WITH RESPECT TO TUNNELS

HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO CALIFORNIA

SHAFTS ON MAIN AQUEDUCT LINES

GENERAL DIMENSIONS OF SHAFTS

POSITIONS OF SHAFTS WITH RESPECT TO TUNNELS.

DEPARTMENT OF PUBLIC WORKS. APPROVED _____ CITY ENGINEER

BY J.H.T. TRACED J.H.T. CHECKED R.R.H.

SCALE As shown DATE Dec. 1927 July 5, 1928

A - 336

The names, locations, and approximate depths of the shafts (including depth of rock pockets, 35 feet below tunnel grade) in this division are as follows:

Name	Location	Approx. depth
Thomas Shaft	Thomas Gulch	337 feet
Mitchell Shaft	Mitchell Ravine	790 "
Mocho Shaft	Arroyo Mocho	804 "
Valle Shaft	Arroyo Valle	356 "
Indian Creek Shaft	Indian Creek	289 "

Construction work has been commenced at the Mocho and Valle shaft camps by City forces.

Mocho Shaft: In April, May and June, 1927, construction of the Mocho Shaft camp was commenced and carried as far as necessary to accommodate the shaft sinking crew and small road and transmission line construction crews operating in the vicinity. A combined dining room and kitchen, 6 five-men bunk houses, bath houses, toilets, a blacksmith shop and a small warehouse have been erected, two 15,000 gallon water tanks were installed and water mains with fire-fighting stands were constructed. Kitchen water was piped from a spring 2000 feet distant and a gas engine driven pump takes additional water from Mocho Creek.

A temporary head frame was erected over the shaft and with a temporary plant, shaft sinking was commenced in May. A small drift was run in from about creek level, 94 feet below the collar of the shaft, and a small shaft was sunk to meet this drift. The small shaft is now being enlarged to the full size of the construction shaft, the excavated material being removed through the drift. On June 30, 1927, a crew of 19 men, working 2 shifts, was engaged in this enlargement and up to that date had enlarged the upper 35 feet to full size and timbered it.

Valle Shaft: During the month of June, 1927, a small crew was engaged in the construction of camp buildings at the Valle Shaft site. The kitchen and dining room building was completed and work was started on the bunk houses and warehouse. A crew on the telephone and transmission line construction cleared the right of way and dug pole holes between Mocho Shaft and Valle Shaft.

Bay Development

The Bay Development of the Hetch Hetchy Aqueduct, comprising the Bay Crossing Pipe line and the Pulgas Tunnel and extending from a point near Irvington, Alameda County, to Crystal Springs Reservoir, San Mateo County, has been operated throughout the year by the Spring Valley Water Company. An annual rental of $250,000 accrues to the City for the Company's use of this section of the Aqueduct.

A detailed description of the pipe line and related structures, with map, appears in the report of this office for 1925-1926, pages 62 to 73.

The cost of the Bay Development work as shown by the final costs accounts was: Engineering and Construction $5,721,520; land, $225,-244; total, $5,946,764.

For the pressure conditions that will obtain when the Hetch Hetchy Aqueduct is completed, with gravity operation, the nominal capacity of the line is 45,000,000 gallons. The actual delivery capacity under present conditions is limited to that of the pumps installed at the Bay-Pulgas Pumping Plant, which is about 34,500,000 gallons daily.

The average daily delivery for the fiscal year was 32,000,000 gallons; for September, 1926, which was the month of maximum delivery, 34,140,000 gallons; for January, 1927, which was the month of minimum delivery, 26,600,000 gallons.

Increase of Stored Water in Peninsular Reservoirs:

For several years preceding completion of the Bay Development of the Aqueduct, the annual draft from the Spring Valley Water Company's three Peninsular storage reservoirs. Crystal Springs, San Andres and Pilarcitos, exceeded the annual inflow. This resulted in drawing down the quantity of water in storage in these reservoirs to very low levels, the minimum for 1924 being about 3,600,000,000 gallons, 12 per cent of the combined capacity of the three reservoirs. The situation was very serious in January, 1926, when only 70 days' storage of water remained in the entire supply system of the Spring Valley Water Supply System.

The quantity now brought from Alameda County through the Hetch Hetchy Aqueduct into Crystal Springs Reservoir and through the Company's old Alameda Pipe Line directly to San Francisco, plus the yield of the Peninsula watershed, exceeds the present requirements for City and suburban consumption plus the loss by evaporation from the reservoirs. The water level in Crystal Springs Reservoir rose 27 feet in 1927 due to the new transbay pipe. This excess goes to build up the depleted storage on the Peninsula. The increase in stored water during the last two fiscal years is shown by the following table:

Water Stored in Spring Valley Reservoirs

Reservoirs	Capacities	Water in storage June 30			Storage 6/30/27 as % of capacity
		1925	1926	1927	
Peninsular System:		Millions of Gallons			
Crystal Springs	22,512	3,622	4,647	12,168	54
San Andres	6,230	2,711	1,045	3,021	48
Pilcarcitos	1,031	653	659	965	94
Total Peninsular	29,773	6,986	6,351	16,154	54
Alameda System:					
Calaveras	32,780	3,668	7,841	9,722	30
Total Peninsular and Alameda.	62,553	10,654	14,192	25,876	38

The delivery of water to Crystal Springs through the completed Bay Crossing Pipe Line commenced in May, 1926. The increase in Peninsular storage from June 30, 1926, to June 30, 1927, was due entirely to use of the City's line. On this point, the total Peninsular storage, and not merely that in Crystal Springs, is the significant figure, as the three reservoirs constitute an operating unit. Water from Pilarcitos is transferred to San Andres by gravity, and part of the Crystal Springs water is pumped to San Andres, as dictated by varying service requirements.

Service Connections:

The development of the hilly section traversed by the 60" steel pipe line between the westerly boundary of Redwood City and Pulgas Tunnel has been materially aided by the installation of the City's aqueduct. Since no other reliable source of water supply was available subdividers and individual lot owners have applied for and been granted service by the Spring Valley Water Company. In each case connection for this purpose is made by the Company to the most conveniently located outlet fitting already installed on the pipe line. The property owner must first secure a revocable permit from the Board of Public Works allowing him to make the connection and lay his branch pipe across the City's land.

Pipe Line Protection in Newbridge Park:

In "Newbridge Park," a recently subdivided tract lying between Bay Road and the Southern Pacific Railroad track and bounded on the east by Willow Road, east of Redwood City, several new streets cross the Hetch Hetchy Aqueduct right of way, as permitted by a condition in the deed by which the City acquired its property. The earth cover over the pipe line is quite shallow through the greater part of the tract, and to protect the pipe the subdivision company was required to construct several reinforced concrete slabs at street crossings, and concrete curbs to keep vehicles from passing over the pipe where there are no protecting slabs. This work was done by the realty company at its own expense. The slabs were designed in the City Engineer's office and constructed under his inspection.

A similar slab was constructed at City expense in connection with the paving of Willow Road, the county road leading to Dumbarton Highway Bridge.

EAR 1926-1927

CONTRACT NO.			AMOUNT PAID	REMARKS
77-C	Const tunne cost-	52	$ 8,309,999	Actual construction completed. Formal acceptance not yet made.
95	Const for a Dumba	84	1,181,400	
100	Furni gate	35	18,323	
105	Const pipe	30	354,606	
110	Makin and n Hetch	84	21,017	
112	Furni plow	32	2,732	
113-C	Const tunne	53	306,126	
113-E	Const tunne	45	209,209	
114	Furni wroug	97	27,129	
115	Furni cedar			All bids rejected on Apr. 18, 1927
116	Furni coppe	65		
117	Furni insul	68		
118-3	Furni trans	25		
118-4	Furni switc arres	00		
118-5	Furni disco	48		

	d	Totals
	3	$ 16,067,197
	8	1,605,207
	1	17,672,404
	5	8,825,334
	6	$ 26,497,738

HETCH HETCHY WATER SUPPLY CONTRACTS IN FORCE DURING FISCAL YEAR 1926-1927

CONTRACT NO.	TITLE OF CONTRACT	DIVISION TO WHICH CHARGEABLE	GENERAL DESCRIPTION	CONTRACTOR	DATE OF SIGNING CONTRACT	TIME ALLOWED IN DAYS	DATE OF ACCEPTANCE	AMOUNT OF BID	AMOUNT PAID	REMARKS
			1910 WATER CONSTRUCTION FUND ($45,000,000 BOND ISSUE)							
77-C	Construction of aqueduct tunnels in Mtn. Div. on a cost-plus-fee basis	Mountain	Aqueduct tunnel, Early Intake to Priest Portal	Construction Company of North America, 431 Mills Bldg., S. F.	Mar. 3, 1920	1000		$ 7,802,952	$ 8,309,999	Actual construction completed. Formal acceptance not yet made
95	Construction of substructures for steel bridge across Dumbarton Strait	Bay Crossing	37 concrete piers, including large east end pier or caisson	Healy-Tibbitts Construction Co. 64 Pine St., S.F.	Nov. 8, 1923	Apr. 1, 1924	Aug. 20, 1926	1,192,484	1,181,400	
100	Furnishing and delivering gate valves	Bay Crossing	2-42", 1-36" and 4-20" gate valves for pipe line and pump plant	Union Machine Co., 934 Brannan St., S.F.	Mar. 8, 1924	120	July 13, 1926	18,335	18,323	
105	Construction of submarine pipe lines	Bay Crossing	Laying flexible joint CI pipe across Newark Slough and Dumbarton Strait.	Healy-Tibbitts Construction Co. 64 Pine St., S.F.	Oct. 15, 1924	180	Sept. 1, 1926	343,230	354,606	
			1925 WATER CONSTRUCTION FUND ($10,000,000 BOND ISSUE)							
110	Making core borings along and near the line of the Hetch Hetchy Aqueduct	Coast Range	Core borings for location study for tunnels between Tesla Portal and Irvington Portal	International Diamond Drill Co. 501 Hobart Bldg., S.F.	Feb. 18, 1926	100	Sept. 13, 1926	18,884	21,017	
112	Furnishing and delivering plow steel cable	Foothill	2½" track cable for cableway at Red Mountain Bar.	E. H. Edwards Co., 225 Bush St., S.F.	Mar. 19, 1926	60	Sept. 23, 1926	3,132	2,732	
113-C	Construction of Aqueduct tunnels	Foothill	Driving and lining tunnel in Rock River and Oakdale Sections	A. Guthrie & Co., 625 Market St., S.F.	Sept. 29, 1926	800	not completed	1,257,953	306,126	
113-E	Construction of Aqueduct tunnels	Foothill	Driving tunnel in Brown Section	Connolly and DeLuca, 461 Market St., S.F.	Sept. 28, 1926	700	not completed	779,745	209,209	
114	Furnishing and delivering wrought steel pipe	Foothill	Compressed air pipe line for aqueduct tunnel construction.	R. W. Kinney Co. 645 Howard St., S.F.	Aug. 6, 1926	Delivery as ordered	Dec. 8, 1926	27,097	27,129	
115	Furnishing and delivering cedar poles	Coast Range	For transmission and telephone lines, Tesla Portal to Irvington Portal							All bids rejected on Apr. 18, 1927
116	Furnishing and delivering copper wire	Coast Range	Do	Anaconda Sales Co. 575 Mission St., S.F.	June 4, 1927	60		11,565		
117	Furnishing and delivering insulators and pins	Coast Range	Do	Westinghouse Elect and Mfg. Co., 1 Montgomery St., S.F.	May 5, 1927	60		6,268		
118-3	Furnishing and delivering transformers	Coast Range	Seco Substation equipment 4- 2000 KVA transformers	Allis Chalmers Mfg. Co. Rialto Bldg., S.F.	May 16, 1927	120		72,125		
118-4	Furnishing and delivering switch gears & lightning arresters	Coast Range	Seco Substation equipment	H.B. Squires Co. 583 Howard St., S.F.	May 20, 1927	120		40,600		
118-5	Furnishing and delivering disconnecting switches	Coast Range	Seco Substation equipment	Garland-Affolter Eng. Co., Rialto Bldg., S.F.	June 13, 1927	120		5,648		

TOTALS PAID UNDER CONTRACTS

	1910 Fund	1925 Fund	Totals
Contracts completed prior to July 1, 1926, brought forward from previous report	$ 16,021,934	$ 45,263	$ 16,067,197
Contracts completed during fiscal year 1926-27	1,554,329	50,878	1,605,207
Total, contracts completed to June 30, 1927	17,576,263	96,141	17,672,404
Contracts not yet completed	8,309,999	515,335	8,825,334
Total amounts paid, all contracts	$ 25,886,262	$ 611,476	$ 26,497,738

Expenditures on Hetch Hetchy Project
June 30, 1927

1909 and 1910 Bond Funds Together with Amount Advanced from General Fund Prior to Bond Issues

Code	Account	Fiscal Year 1926-1927	Total to June 30, 1927
	General Expenditures		
2001	Preliminary Water Supply Investigations	$	$ 140,408.29
2002	Lands, Water Rights, and Rights of Way	1,847.91	1,742,974.40
2003	Rentals to U. S. Government		106,018.11
2004	Legal Expense		179,818.03
2005	Hydrography		63,879.95
2006	City Office Administration	2,029.25	448,706.80
2007	City Office Engineering	19,778.94*	379,764.32
2009	Taxes	6,696.49	62,456.07
2012	Unamortized Expense, Sale of Bonds		26,877.36
2016	S. F.-San Mateo Water Supply Survey	3,000.00*	
A-16	City Engineer's Revolving Fund		20,000.00
	TOTAL GENERAL EXPENDITURES	$ 12,205.29*	$ 3,170,903.33
	Construction Expenditures		
1000	Hetch Hetchy R. R. (Incl. Net Operation)	61 941.03*	2,761,472.63
2008	State Compensation Ins., Undist'd		4,680.67
2010	Miscel. Construction Expenditures	2,900.31*	12,271.11
2015	C. R. C. Evaluation, P. G. & E. & G. W. P. Co.'s Properties, S. F.	60,379.03	†307,682.71
2017	Wells in Sunset and Richmond Districts	19,906.44	19,906.44
2018	Tourist Camp, Mather	38,123.67	38,123.67
2101	Groveland Office, Administration & Engineering	1,250.03	257,966.20
2102	Groveland Hospital (Incl. Net Operation)	1,698.27	*123,954.49
2110	Groveland Employees' Dwellings, Less Rents	19.70*	68,438.77
2111	Groveland Warehouse		9,725.96
2112	Groveland Water Supply	.80	33,784.65
2200	H. H. Div. O'Shaughnessy Dam & Appurtenances	1,111.46	8,162,506.93
2300	Lake Eleanor Div., Eleanor Dam & Appurtenances	164.41	392,358.91
2400	Mt. Div., Aq. Tunnels & Structures	70,406.55	10 725,442.66
2500	Priest Div. Dam, Reg. Reservoir & Power Tunnel	15,910.57	2,407,243.42
2600	Moccasin Div., Penstock, Power House & Structures	21,133.74*	4,890,984.91
2700	Foothill Div., Tuolumne R. Crossing at Red Mt. Bar	2,558.45	287,981.40
2800	Lower Cherry Power Development (Inc. Net Operation)	23,339.77	316 693.51
2900	Early Intake Diver. Works, Dam & Appurtenances	5,840.62	890,062.67
3000	Canyon Ranch & Mather Sawmills (Incl. Net Operation)	943.42	156 002.23

Note—Asterisk (*) denotes credits. (†) See note Page 97.

Expenditures on Hetch Hetchy Project
June 30, 1927

1909 and 1910 Bond Issues and General Fund

Code	Account	Fiscal Year 1926-1927	Total to June 30, 1927
	Construction Expenditures—(Continued)		
3200	H. H. Power Trans. Sys. (Moccasin to Newark)	425.70	1,794,335.09
3300	San Joaquin Division, Cost of Lands	155.26*	211,494.10
3400	Coast Range Division, Prel. Surveys		30.00
3500	Golden Rock Ditch (less Water Sales)		6,561.99
4000	Boarding House, Net Operation	30.59*	304,547.85
5000	Materials and Supplies	178,156.00*	54,180.21
6000	Bay Development (Newark to Pulgas), incl. Lands	208,013.84	5,946,764.08
L-73	Electric Energy from H. H. Plants (since 8/15/25)	232.58*	*232.58
	TOTAL CONSTRUCTION EXPENDITURES	$185,503.82	$39,937,055.70
	Miscellaneous Expenditures		
A-12	Accounts Receivable, Miscellaneous Debtors	1,389.81*	11,801.64
A-13	Ac. Receivable, H. H. W. C. Fund (Issue of 1925)	70,992.25	70,992.25
A-18	Remittances in Transit (Deposited with Treasurer after 7/1/27)	19,390.27	20,808.62
	TOTAL MISCELLANEOUS EXPENDITURES	$ 88,992.71	$ 103,602.51
	GROSS EXPENDITURES	$262,291.24	$43,211,561.54
	Revenues During Construction		
500	Rentals from Lands and Rights of Way	2,133.72	21,033.49
501	Sale of Water to Irrigation Districts		164,979.17
502	Use of Pipe Line, Bay Development		24,600.78
503	Miscellaneous Credits	3,547.02	7,190.70
	TOTAL REVENUES	$ 5,680.74	$ 217,804.14
	NET EXPENDITURES	$256,610.50	$42,993,757.40

Note—Asterisk (*) denotes credit.

Expenditures on Hetch Hetchy Project
June 30, 1927

1909 and 1910 Bond Issues and General Fund

Reconciliation of Statement of Expenditures with Consolidated Statement of Funds

Disbursements as per Consolidated Statement of Funds:

1909 Bond Issue		$ 603,033.87	
1910 Bond Issue		42,901,692.77	
General Fund		118,219.93	
Hetch Hetchy Operative Revenue Fund	$1,920,415.99		
Transfer to Bond Interest Fund	620,000.00*	1,300,415.99	$44,923,362.56

Accounts taken into Expenditures as of June 30, 1927, (not taken up by Auditor until after July 1, 1927):

Purchase Order Liability		8,646.18	
Accounts Payable, H. H. Power Operative Funds		26,989.49	
Accounts Payable, Miscellaneous Creditors		184.68	
Accrued on account of Compensation Ins. Prem.		345.12	36,165.47
			$44,959,528.03

Receipts used as reduction of Expenditures:

Operation of Hetch Hetchy R. R.	1,380,876.87		
Sale of Power, Lower Cherry Power Dev.	386,338.54		
Sale of Water	166,324.50		
Use of Pipe Line, Bay Dev. (S.V.W.Co.)	24,600.78		
Miscellaneous	4,093.31	1,962,234.00	
Non-cash credits used as reduction of Expenditures		3,536.63	1,965,770.63
NET EXPENDITURES AS PER DETAILED STATEMENT (Page 96)			$42,993,757.40

NOTE: The foregoing net expenditures include the sum of $307,682.71 (Account 2015, Page 96) which was paid out of the Hetch Hetchy Operative Revenue Fund for valuation of Pacific Gas and Electric Company's and Great Western Power Company's Plants. This charge is not a true Hetch Hetchy Project expenditure and should be deducted when calculating the actual costs of the project.

NOTE: Asterisk (*) denotes credit.

Expenditures on Hetch Hetchy Project
June 30, 1927

1925 Bond Fund

Code	Account	Fiscal Year 1926-1927	Total to June 30, 1927
	Foothill Division		
2700	Division Administration and Engineering	$ 47,580.58	$ 83,457.54
2701	Preliminary Investigations and Surveys	2,757.23*	31,708.16
2702	Field Engineering and Inspection	41,313.64	51,888.53
2703	Camps	19,239.98	293,756.08
2704	Roads, Trails and Tramways	69,152.95	158,199.59
2705	Adits	37,227.73*	8,724.57
2706	Shafts	2,028.75	54,595.52
2707	Aqueduct Tunnels	2,259,600.51	2,489,345.35
2710	Aqueduct Diversion Dam & Appurtenances	26,056.99	26,056.99
2712	Moccasin Creek Diversion Canal	160.81	160.81
2713	Moccasin Crushing Plant	27,821.45	27,821.45
2714	Miscellaneous Jobbing and Sales Account	82.16*	2,131.28
2716	Division Machine Shops (Incl. Operation)	1,807.29*	30,571.78
2717	Division Warehouse (Incl. Operation)	29,343.16*	2,706.14
2718	Lands and Rights of Way	8,647.27	43,510.47
2719	Power Transmission Line for Const. Purposes	10,935.44	48,268.96
2720	Division Administration Buildings & Equipment	2,598.64	53,206.34
2721	Division Hospital (Incl. Operation)	24,077.45*	*17,393.40
2722	Materials and Supplies	29,378.13*	342,279.30
2723	Division Mis. Shops & Equip. (Incl. Operation)	7,175.58*	36,658.14
2724	Division Garage Equipment (Incl. Operation)	15,545.05*	20,505.75
2726	Division Communication System	2,721.22	16,440.40
2727	Camp Operation (Incl. Boarding Houses)	38,582.33	56,768.42
2792	General Administration	38,463.61	65,301.68
2793	General Engineering	31,716.81	49,733.18
2794	Law Expense During Construction	102.75	5,431.38
2797	Miscellaneous Construction Expenditures	63.44	235.90
L-73	Electric Energy from Hetch Hetchy Plants	19,115.78*	*22,629.24
	TOTAL	$2,460,277.61	$3,959,441.07
	San Joaquin Division		
3301	Preliminary Investigations and Surveys	442.10	442.10
	TOTAL	$ 442.10	$ 442.10
	Coast Range Division		
3400	Division Administration and Engineering	2,257.87	2,257.87
3401	Preliminary Investigations and Surveys	27,465.44	45,270.26
3402	Field Engineering and Inspection	1,199.81	1,199.81

Code	Account	Fiscal Year 1926-1927	Total to June 30, 1927
	Coast Range Division—(Continued)		
3403	Camps	15,970.74	15,970.74
3404	Roads, Trails and Tramways	20,605.39	20,605.39
3406	Shafts	6,812.77	6,812.77
3416	Division Shops & Equipment (Incl. Operation)	18,779.65	18,779.65
3417	Division Warehouse (Incl. Operation)	914.54	914.54
3418	Lands and Rights of Way	6,829.47	6,829.47
3419	Power Transmission Line for Const. Purposes	9,194.71	9,194.71
3420	Division Administration Buildings & Equipment	81.60	81.60
3421	Division Hospital	56.99*	*56.99
3422	Materials and Supplies	49,229.71	49,229.71
3424	Division Garage Equipment (Incl. Operation)	3,650.25	3,650.25
3426	Division Communication System	1,667.90	1,667.90
3427	Camp Operation (Incl. Boarding Houses)	184.67	184.67
3492	General Administration	15.72*	201.85
3493	General Engineering	6,043.80	7,024.42
3494	Law Expenses During Construction		7.50
3497	Miscellaneous Construction Expenditures	284.14	284.14
	TOTAL	$ 171,099.75	$ 190,110.26
	General and Miscellaneous		
A-12	Accounts Receivable, Miscellaneous Debtors	5,050.71	5,050.74
A-13	Accounts Receivable, 1910 Water Construction Fund	4,643.23*	
A-13	Accounts Receivable, H. H. Power Operative Fund	6,960.44	835.88
A-18	Remittance in Transit (Deposited after 7/1/27)	24,011.63	24,011.63
A-25	Unamortized Expense on Bonds Sold	871.50	5,311.00
A-26	Prepaid Const. Expend. (July paid in June)	98,872.49	98,872.49
	TOTAL	117,202.66	134,081 71
	TOTAL NET EXPENDITURES	$2,749,022.12	$4,284,075.15

Reconciliation of Statement of Expenditures with Consolidated Statement of Funds 1925 Fund

Disbursements as per Consolidated Statement of Funds		$3,939,171.26
Accounts taken into expenditure as of June 30, 1927: (not taken up by Auditor until after July 1, 1927):		
Purchase Order Liability	$ 98,234.74	
Accounts Payable, Due on Contracts 113C & E	82,836.90	
Accounts Payable, 1910 Water Const. Fund	70,992,25	
Accounts Payable, Miscellaneous Creditors	3,376.26	
Accrued on Contracts 113C & E, Progress Estimate (10 per cent withheld in accordance with Contract)	83,878.87	
Accrued on account of Compensation Ins. Prems.	5,584.86	344,903.88
NET EXPENDITURES AS PER DETAILED STATEMENT		$4,284,075.14

NOTE: Asterisk (*) denotes credit.

Expenditures on Hetch Hetchy Project
June 30, 1927
Hetch Hetchy Operative Revenue Fund

TOTAL RECEIPTS		$1,967,969.00
Transferred to Bond Interest Fund	$620,000.00	
Transferred to P.G.&E. & G.W.P. Co.'s evaluation	307,682.71	
Transferred to H. H. 1910 Water Construction Fund	992,733.28	1,920,415.99
BALANCE AVAILABLE JUNE 30, 1927		47,553.01

Hetch Hetchy Power Operative Fund
Condensed Balance Sheet

Assets and Other Debits	From Operation	1909 & 1910 Bond Issues and Gen'l Fund	Total per Gen'l Ledger June 30, 1927
Fixed Capital in Service	$ 112,323.26	$25,355,208.00	$25,467,531.26
Current and Accrued Assets	1,892,918.78	21,315.85	1,914,234.63
Special Funds (Sinking, Depreciation & Misc. Spec. Funds)	207,091.75		207,091.75
Deferred Debits	123,546.18*	1,569,809.38	1,446,263.20
TOTAL ASSETS AND OTHER DEBITS	$2,088,787.61	$26,946,333.23	$29,035,120.84
Liabilities and Other Credits			
Capital and Long Term Debt	$ 969,512.45*	$26,946,333.23	$25,976,820.78
Current and Accrued Liabilities	899,949.17		899,949.17
Reserve for Depreciation	217,079.22		217,079.22
Appropriated Surplus	1,115,763.76		1,115,763.76
Additions & Betterments $ 91,563.76			
Sinking Funds, Retirement of 1910 Bonds 1,024,200.00			
Unappropriated Surplus	825,507.91		825,507.91
Profit & Loss after Comparison Chgs. 581,456.75			
Taxes chgd. for comparison 266,912.98			
Revenues credited for comparison 22,861.82*			
TOTAL LIABILITIES AND OTHER CREDITS	$2 088,787.61	$26,946,333.23	$29,035 120.84

NOTE: Asterisk (*) denotes deductions.

Expenditures on Hetch Hetchy Project
June 30, 1927
Hetch Hetchy Power Operative Fund
Income Statement

Income from Operating Properties	10½ Mos. to June 30, 1926	Fiscal Year 1926-1927	Total to June 30, 1927
Operating Revenues:			
Moccasin Creek Power House	$7,403,693.40	$ 8,553,129.32	$15,956,822.72
Early Intake Power House	48,699.70	42,405.00	91,104.70
TOTAL OPERATING REVENUES	$7,452,393.10	$ 8,595,534.32	$16,047,927.42
Operating Expenses:			
Production	$ 116,141.39	$ 162,596.43	$ 278,737.82
Transmission	11,820.35	30,512.65	42,333.00
Distribution	83.44	61.39	144.83
Commercial Department	5,408,913.66	6,223,561.62	11,632,475.28
General & Miscellaneous	111,763.50	223,402.55	335,166.05
TOTAL OPERATING EXPENSES	$5,648,722.34	$ 6,640,134.64	$12,288,856.98
NET OPERATING REVENUE	$1,803,670.76	$ 1,955,399.68	$ 3,759,070.44
Deduct Taxes Assignable to Operations	556.35	4,967.34	5,523.69
NET OPERATING & GROSS INCOME	$1,803,114.41	$ 1,950,432.34	$ 3,753,546.75
Deductions from Gross Income			
Interest on Long Term Debt	$ 788,854.50	$ 875,650.50	$ 1,664,505.00
Miscellaneous Interest Deductions	15,979.22	15,843.09	31,822.31
Amortization of Debt Dis. & Expense	54,108.06	61,839.71	115,947.77
TOTAL DEDUCTIONS	$ 858,941.78	$ 953,333.30	$ 1,812,275.08
NET INCOME	$ 944,172.63	$ 997,099.04	$ 1,941,271.67
Disposition of Net Income			
Appropriated for Additions & Betterments		$ 91,563.76†	$ 91,563.76
Approp. for Retirement of 1910 Bonds	512,100.00	512,100.00	1,024,200.00
TOTAL APPROPRIATIONS	$ 512,100.00	$ 603,663.76	$ 1,115,763.76
BALANCE FOR ACTUAL SURPLUS	$ 432,072.63	$ 393,435.28	$ 825,507.91
Charter Requirements for Comparison			
Add. Revenue charged H.H.W.S. Const.	3,746.04	19,115.78	22,861.82
	$ 435,818.67	$ 412,551.06	$ 848,369.73
Deduct, Taxes	126,194.61	140,718.37	266,912.98
BALANCE AFTER COMPARISON CHARGES	$ 309,624.06	$ 271,832.69	$ 581,456.75

†$12,379.80 applies to period prior to July 1, 1926.

Expenditures on Hetch Hetchy Project
June 30, 1927

Addenda

Interest Received on Bay Development Expenditures

	Principal	Interest
April 18, 1922 to May 31, 1924		$ 58,232.05
June 1, 1924 to April 17, 1925	$4,796,086.43	170,451.54
TRANSFERRED TO 1910 BOND INTEREST FUND		228,683.59
July 1, 1925, to June 30, 1929	5,000,000.00	
TRANSFERRED TO 1910 BOND FUND		883,390.64

Interest Received on Accounts Receivable and Surplus Funds Invested

July 1, 1919, to June 30, 1926 (1910 Bond Fund)		
CREDITED TO 1910 BOND INTEREST FUND		$2,910,471.16
November 1, 1918, to June 30, 1924 (Hetch Hetchy Operative Revenue Fund)		
Accounts Receivable Hetch Hetchy Railroad	$	19,006.67
Surplus Funds, Invested		5,735.00
CREDITED TO HETCH HETCHY OPERATIVE REVENUE FUND		24,741.67

Receipts from Water Crop

Waterford Irrigation District	$	750.00
Turlock Irrigation District		90,000.00
Modesto Irrigation District		74,229.17
	$	164,979.17
Sales from Golden Rock Ditch		1,345.33
CREDITED TO HETCH HETCHY OPERATIVE REVENUE FUND	$	166,324.50

Receipts from Use of Pipe Line—Bay Development

September to December, 1925	
CREDITED TO HETCH HETCHY OPERATIVE REVENUE FUND	$24,600.78

	Hetch Hetchy Power Operative Fund		
	perative	Depreciation	TOTALS
RECEIPTS		$	$
Par Valu			51,000,000.00
Add Pr			121,609.00
Deduct Bonds			2,980,326.55
Net Pr			48,141,282.45
Advanced			118,151.02
Transfer Funds t			
Interest vested			5,735.00
Advance Valley			883,390.64
Operatio			
Railroa			1,380,876.87
Sale of Power D			386,338.54
Sale of			166,324.50
Use of P ment			24,600.78
Miscella			4,093.31
Operatin	161,007.02		4,161,007.02
*Depreciation ferred	243,749.00*	243,749.00	
Tot	917,258.02	243,749.00	55,271,800.13
DISBURS. For Cons and Ope except which i above	307,469.04		49,062,320.15
For Char Reserve		41,157.26	41,157.26
For Bond to 1910	144,500.00		1,764,500.00
For Bond ferred tion Fu	598,500.00		598,500.00
For Cali Evaluat Plants)			307,682.71
Tot	250,469.04	41,157.26	51,774,160.12
CASH BAL	666,788.98	202,591.74	3,497,640.01

*Indicat

HETCH HETCHY PROJECT

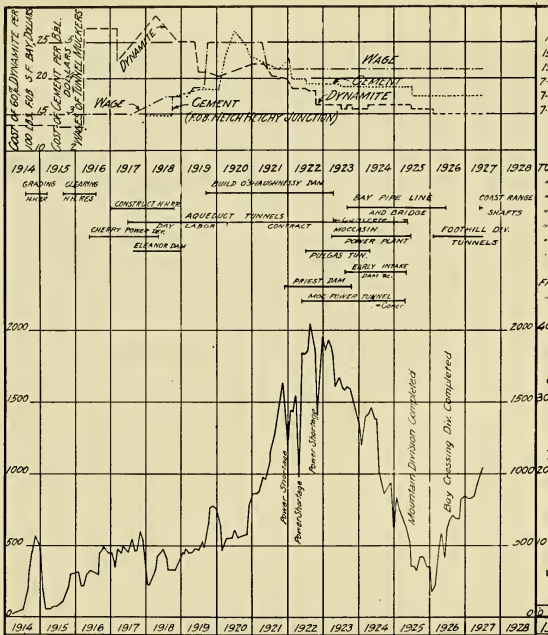
CONSOLIDATED STATEMENT OF FUNDS - JUNE 30th, 1927

	Bond Issues			General Fund	H.H.Operative Revenue Fund	Hetch Hetchy Power Operative Fund		TOTALS
	1909	1910	1925			Operative	Depreciation	
RECEIPTS:	$	$	$	$	$	$	$	$
Par Value of Bonds Sold	600,000.00	45,000,000.00	5,400,000.00					51,000,000.00
Add Premiums, Sale of Bonds	3,050.00	11,348.00	107,211.00					121,609.00
Deduct Discount, Sale of Bonds		2,980,326.55						2,980,326.55
Net Proceeds, Sale of Bonds	603,050.00	42,031,021.45	5,507,211.00					48,141,282.45
Advanced from General Fund				118,151.02				118,151.02
Transferred from 1909 & 1910 Funds to General Fund	16.13*	52.78*		68.91*				
Interest Earned on Funds Invested					5,735.00			5,735.00
Advance Payments by Spring Valley Water Company		883,390.64						883,390.64
Operation of Hetch Hetchy Railroad					1,380,876.87			1,380,876.87
Sale of Power, Lower Cherry Power Development					386,338.54			386,338.54
Sale of Water					166,324.50			166,324.50
Use of Pipe Line, Bay Development					24,600.78			24,600.78
Miscellaneous					4,093.31			4,093.31
Operating Revenues						4,161,007.02		4,161,007.02
*Depreciation Reserve, Transferred from Operative						243,749.00*	243,749.00	
Total Receipts	603,033.87	42,914,359.31	5,507,211.00	118,219.93	1,967,969.00	3,917,258.02	243,749.00	55,271,800.13
DISBURSEMENTS:								
For Construction of Project and Operation of Utilities, except *depreciation expense which is shown as a transfer above	603,033.87	42,901,692.77	3,939,171.26	118,219.93	992,733.28	507,469.04		49,062,320.15
For Charges to Depreciation Reserve							41,157.26	41,157.26
For Bond Interest, Transferred to 1910 Bond Interest Fund					620,000.00	1,144,500.00		1,764,500.00
For Bond Redemptions, Transferred to 1910 Bond Redemption Fund						598,500.00		598,500.00
For Calif. Railroad Commission Evaluation (P.G.& E. and G.W.P. Plants)					307,682.71			307,682.71
Total Disbursements	603,033.87	42,901,692.77	3,939,171.26	118,219.93	1,920,415.99	2,250,469.04	41,157.26	51,774,160.12
CASH BALANCES - JUNE 30, 1927		12,666.54	1,568,039.74		47,553.01	1,666,788.98	202,591.74	3,497,640.01

*Indicates Deductions

Contractual Liabilities, Hetch Hetchy Water Construction Fund

Cont. No.	Name of Contractor	Object of Expenditure		Amount of Contract	Amount Due June 30, 1927
113-C	A. Guthrie & Co.	Const. Aqueduct Tunnels, Rock River & Oakdale Sections		$ 1,257,952.50	$ 814,281.32
113-E	T. E. Connolly & J. M. DeLuca	Foothill Division, Brown Adit Section		779,745.00	464,526.30
116	Anaconda Sales Co.	Copper Wire, Transmission Line	Coast Range Div.	11,565.00	11,565.00
117	Westinghouse Electric & Manufacturing Co.	Insulators	"	6,268.16	6,268.16
118-3	Allis Chalmers Mfg. Co.	Transformers	"	72,125.00	72,125.00
118-4	H. B. Squires Co.	Switch Gear & Lighting Arresters	"	40,600.00	40,600.00
118-5	Champion Switch Co.	Disconnecting Switches	"	5,648.00	5,648.00
	TOTALS			$2,173,903.66	$1,415,013.78
	ADD: Amounts deducted from payments to contractors account of labor and material furnished by City:				
	Contract No. 113-C			$ 137,918.44	
	Contract No. 113-E			101,656.42	
	Deduction made from contract 113-E account of overbreak in tunnel excavation			4,353.72	
	Deduction made from completed contract 114 account actual quantity under estimate			2,870.96	246,799.54
					$1,661,813.32
	DEDUCT: Allowance made on Contract No. 113-C account of additional timber			373.69	
	Payment on Contract No. 116 made after July 1, but included by Auditor as of June 30			11,565.00	11,938.69
	BALANCE AS PER AUDITOR, JUNE 30, 1927				$1,649,874.63

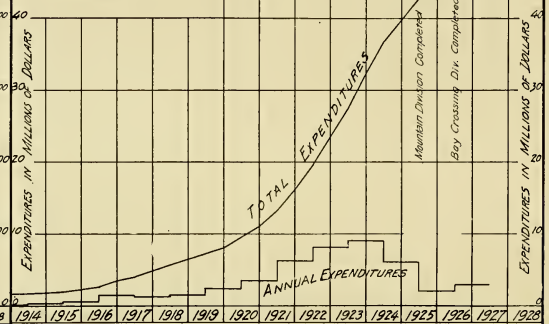


EXPENDITURES PRIOR TO 1914.

FOR PERIOD	
1900 TO 1906	$ 43,999.39
1907 TO 1910	74,220.54
7-1-10 TO 6-30-12	1,382,287.72
7-1-12 TO 6-30-13	193,543.65
7-1-13 TO 6-30-14	56,255.14

TOTALS	
TO 1906	$ 43,999.39
" JULY 31, 1910	118,219.93
" DEC 31, 1911	721,434.99
" JUNE 30, 1912	1,300,507.65
" DEC 31, 1912	1,636,209.45
" JUNE 30, 1913	1,694,051.30
" DEC 31, 1913	1,721,486.13

FROM GENERAL FUND	$ 118,219.93
" 1909 BONDS	603,215.06



HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

UPPER: GRAPHIC RECORDS OF COSTS OF LABOR AND MATERIALS.
LOWER: GRAPHIC RECORD OF NUMBER OF MEN EMPLOYED.
NOTE: EMPLOYEES IN THE SAN FRANCISCO OFFICES ARE NOT INCLUDED IN THE COUNT.

DEPARTMENT OF PUBLIC WORKS. APPROVED _____ CITY ENGINEER
BY L.B.C. TRACED L.B.C. CHECKED _____
SCALE _____ DATE _____

A - 302

HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

GRAPHIC RECORDS OF
ANNUAL AND TOTAL EXPENDITURES.

DEPARTMENT OF PUBLIC WORKS. APPROVED _____ CITY ENGINEER
BY L.B.C. TRACED L.B.C. CHECKED _____
SCALE _____ DATE _____

A - 303